Coso Monitoring Program
October 1997 Through September 1998

by
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Public Works Department

JANUARY 1999

NAVAL AIR WEAPONS STATION
CHINA LAKE, CA 93555-6100

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Naval Air Weapons Station

FOREWORD

This report presents the status of the Coso Monitoring Program conducted for the period October 1997 through September 1998 by the Naval Air Weapons Station (NAWS), China Lake, Calif. The investigation, funded under the NAWS Coso Geothermal Development Program, is being conducted to provide baseline information on hydrology and surface geothermal activity in the Coso Hot Springs area.

This report was reviewed for technical accuracy by Allan M. Katzenstein and Steven C. Bjornstad (NAWS 83G000D).

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(U) The Coso Monitoring Program is a continuing effort in support of the Navy's geothermal resources within the Coso Known Geothermal Resource Area (Coso KGRA). A substantial body of reports has been established on this project (15 technical publications) and the project is essentially the same year to year, therefore much of the text of each report reiterates previously published information. This year's report concentrates on data presentation and interpretation; the reader is referred to the 1993/1994 summary report (NAWS-CL TP 006) for detailed descriptions of the overall project and the individual sites monitored.

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CONTENTS

Figures:

Tables:

INTRODUCTION

The Coso Monitoring Program was initiated in 1978 to gather baseline data on the surface and near-surface geothermal activity at Devils Kitchen and Coso Hot Springs which are the main active thermal features within the Coso Known Geothermal Resource Area (Coso KGRA). These two sites are also located inside the boundaries of the Naval Air Weapons Station (NAWS), China Lake, Calif. This report represents the twentieth consecutive year of continuous data collection at these sites by Geothermal Program Office personnel.

The format of the report for the current reporting period hasn't been changed from last year's report. A substantial body of reports has been established on this project (15 technical publications) and the project is essentially the same year to year, therefore much of the text of each report reiterates previously published information. This year's report concentrates on data presentation and interpretation and the reader is referred to the 1993/1994 summary report (Reference 1) for detailed descriptions of the overall project and the individual sites monitored.

Seasonal and diurnal variations of the thermal activity in these hot spring areas continue to be evident. Minor increases in thermal activity have been noted during this reporting period.

Monitoring sites of the Coso Hot Springs area and type of data collected at each site are presented in Table 1. The location of each site is shown in Figure 1.

TABLE 1. Monitoring Functions and Locations.

Monitored sites	Continuous steam flow	Wellhead pressure	Periodic water level	Periodic water temperature	Water level photography	Water chemistry	Ambient temperature	Barometric pressure	Relative humidity	Wind speed and direction
Schober's Resort (Wells 4A-2, 3)	X									
Well 4A-4			X[a]	X						
Well 4H-4	X									
Well 4P-1			X[b]	X		X				
Well 4H-8 (Coso No. 1)		X[c]		X						
Devils Kitchen	X					X				
Observation Well No. 1			X[b]	X		X				
Observation Well No. 2			X[b]							
South Pool			X[b]	X	X	X				
Weather Station							X	X	X	X

[a] Less than weekly monitoring.

[b] Weekly monitoring.

[c] Weekly shut-in wellhead pressures.

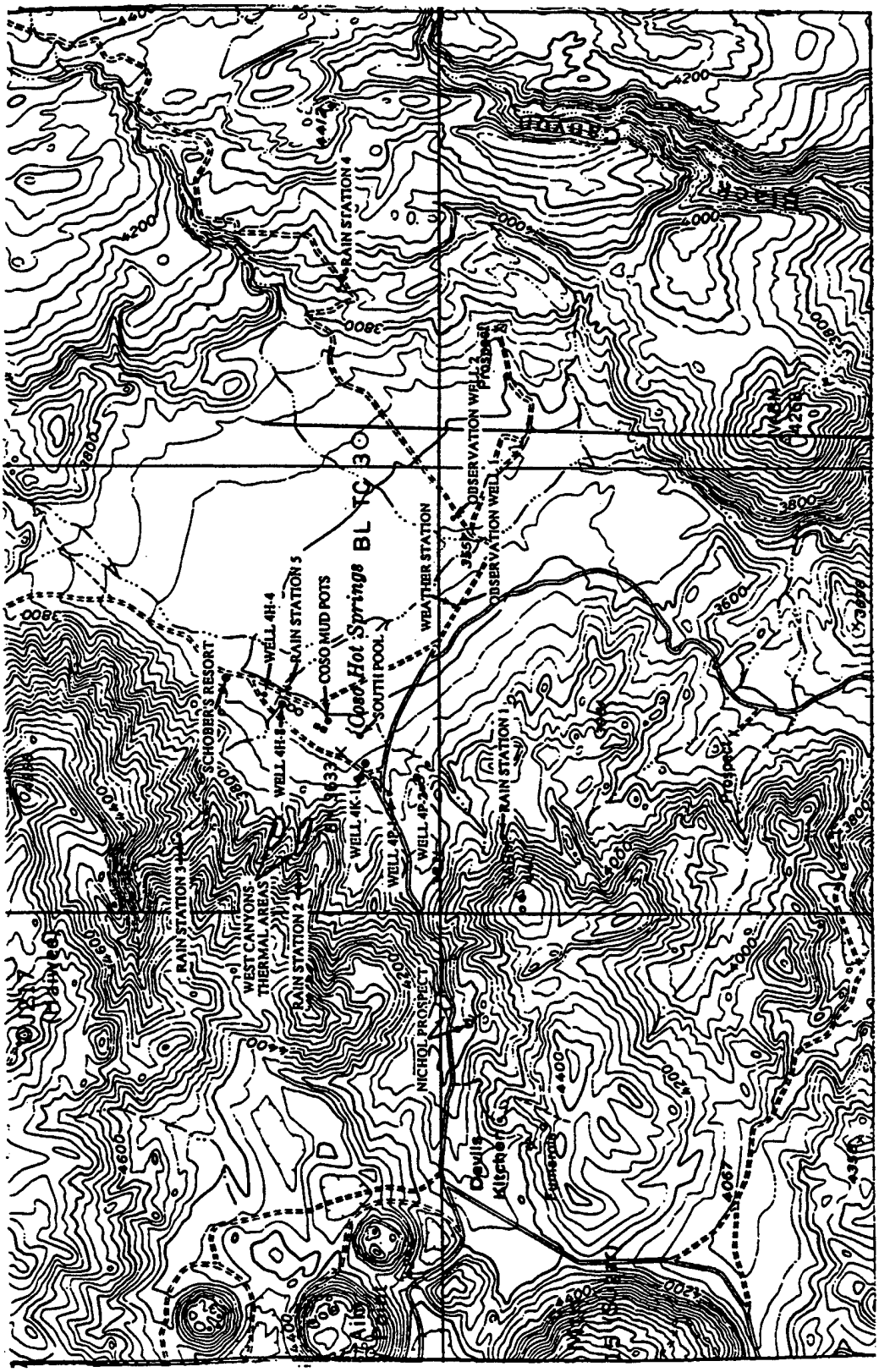


FIGURE 1. Coso Known Geothermal Resources Area Monitoring Sites.

STEAM FLOW AND TEMPERATURE MONITORING

Steam flow has been gauged at several shallow wells since the monitoring program was first initiated. While the measured steam flow from these wells represents an uncertain fraction of the total steam flow from the Coso thermal area, it does serve to monitor the relative hydrothermal activity in the area over time. Several sites are currently included in the study: Devils Kitchen, the Stove Pipe Eight-Inch Well (4H-4), and Schober's Resort (4A-2 and 3).

Steam flow data are recorded at each site using an ITT Barton differential pressure unit (DPU) AdScan recorder. The data are down-loaded to a pocket-size flash memory card. The information stored in the flash memory card is then transferred into Paradox databases.

A periodic maintenance schedule was established in house to ensure that the recording units are maintained at peak efficiency and reliability. Additionally, a contract was established with ITT Barton for yearly maintenance and calibration of the Barton meter/AdScan units. On 16 June 1998 the copper plumbing at Devils Kitchen was replaced with stainless steel piping. The door seals were replaced at Devils Kitchen, 4H-4, and Schober's Resort, and desiccant pads were placed inside the units to keep moisture out. Excessive moisture was causing the charts to deform. The AdScan units were calibrated on 28 April 1998.

DEVILS KITCHEN

Steam flow at Devils Kitchen is monitored using a Barton 25-inch water DPU and AdScan recorder. Daily high, low, and average steam flow data collected at Devils Kitchen for the period of this report are presented in the Appendix. Figure 2 shows a summary graph of Devils Kitchen steam flow activity from October 1997 through September 1998.

From 4 December 1997 through 28 January 1998 the steam flow data recorded at Devils Kitchen showed a marked increase; this data increase was caused by a linkage and calibration problem with the DPU and the AdScan recorder. On 28 January 1998 the linkage was repaired and the recorder was recalibrated, returning the data recorded to a consistent level. On 29 April 1998 yearly maintenance and calibration was performed on the DPU by the ITT Barton representative—this caused a marked decrease in the AdScan data recorded. The Barton representative recommended replumbing the unit to repair leaks in the corroded copper tubing. On 16 June 1998, the suggested plumbing repairs were made, bringing the amount of data obtained back to a consistent level. On 24 August 1998, the DPU/AdScan unit was recalibrated, and following that the accuracy of the data recordings returned to what was being recorded previous to December. Data covering the period of 9 through 12 February 1998 and 1 through 7 April 1998 were lost as a result of a data transfer error.

STOVE PIPE EIGHT-INCH STEAM WELL (4H-4)

The daily steam flow for well 4H-4 is presented in the Appendix. This site is equipped with a 50-inch water column DPU and AdScan recorder. Figure 3 shows a summary graph of steam flow activity from October 1997 through September 1998. The increased steam flow measured in the AdScan data in early September 1998 could be a result of increased thermal activity around the Coso 1 Array next to well 4H-4 (Figures 4 and 5). Data covering the periods of 17 March 1998 through 21 April 1998 and 1 through 8 September 1998 were lost as a result of a data transfer error.

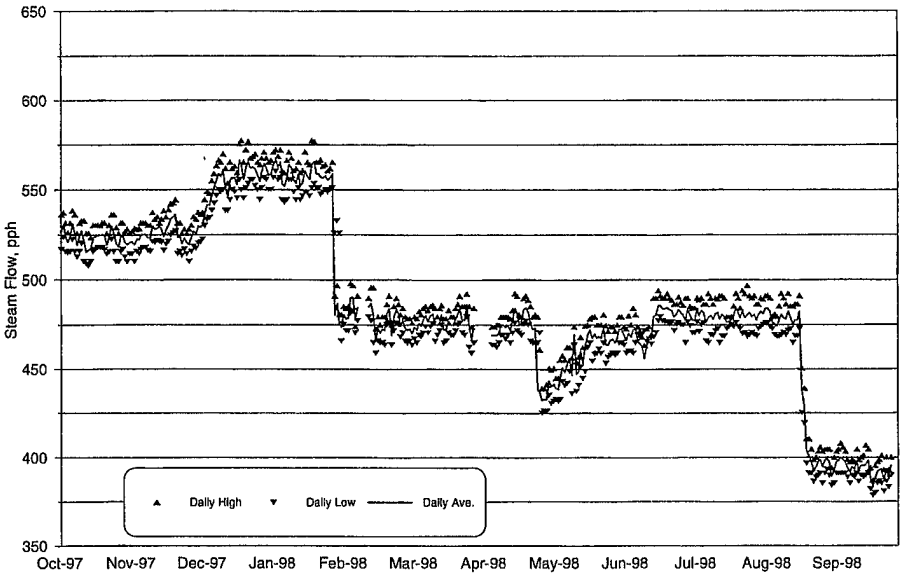


FIGURE 2. Devils Kitchen Steam Flow, October 1997 through September 1998.

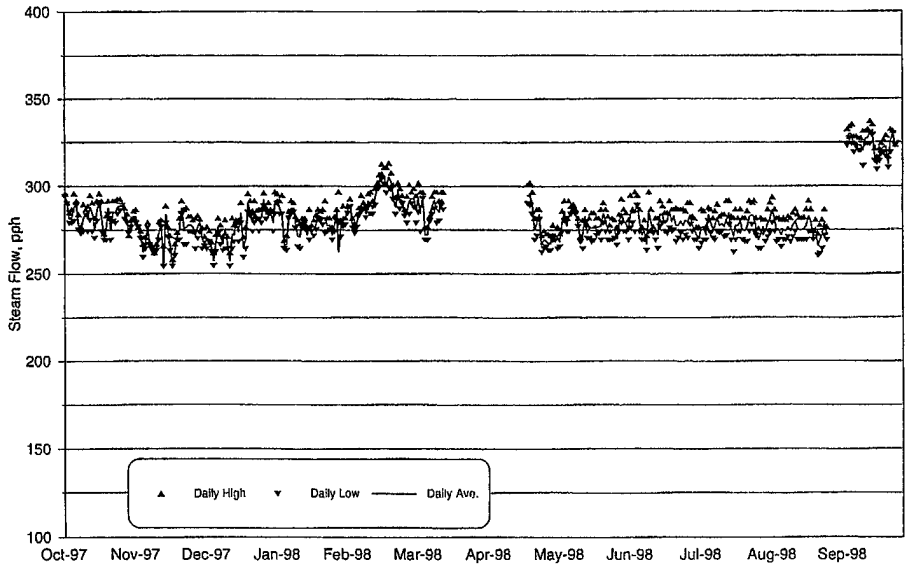


FIGURE 3. Well 4H-4 Steam Flow, October 1997 through September 1998.

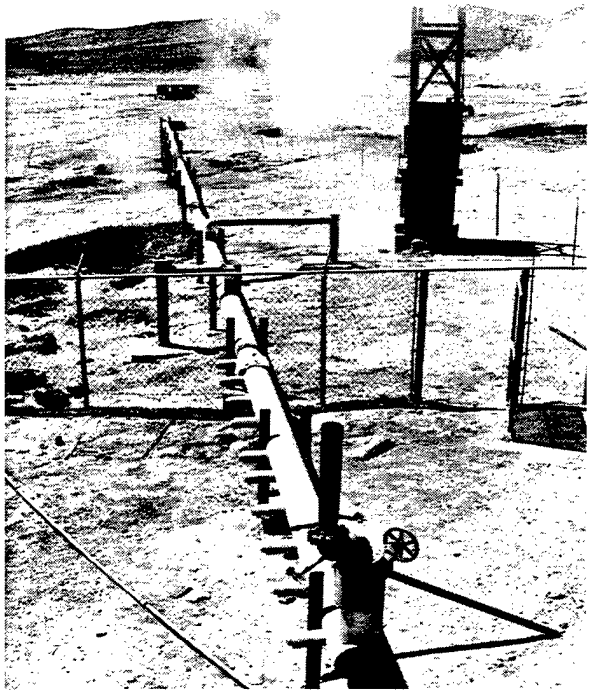


FIGURE 4. The Coso 1 Array, 1996.

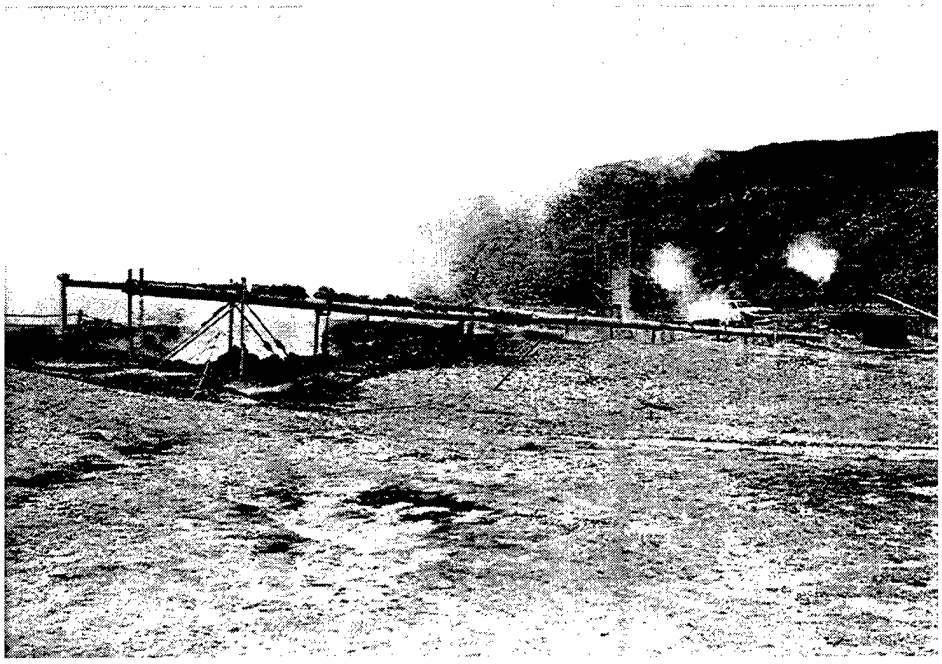


FIGURE 5. The Coso 1 Array, 1998.

SCHOBER'S WELLS (4A-2 AND 4A-3)

The daily steam flow for wells 4A-2 and 4A-3 at Schober's Resort are presented in the Appendix. The Schober's Resort site is equipped with a 50-inch water column DPU and AdScan recorder. Figure 6 shows a summary graph of steam flow activity from October 1997 through 30 September 1998. From late March 1998 through September 1998 the steam flow data recorded at Schober's Wells showed a decrease. This situation is still being assessed. The steady decline in steam flow measured during this reporting period corresponds with the visual observations of the surface steam flow, which also seems to have diminished over the last year.

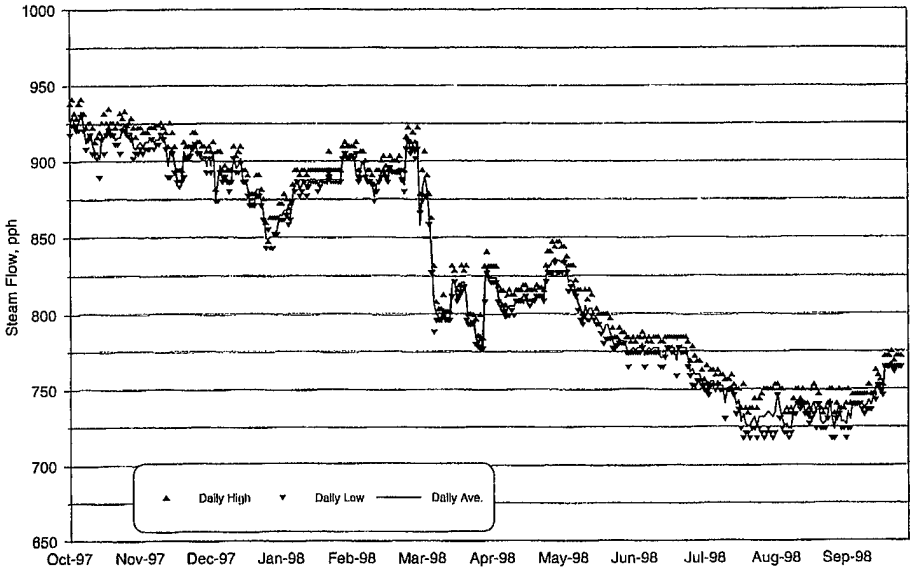


FIGURE 6. Wells 4A-2 and 4A-3 Steam Flow, October 1997 Through September 1998.

COSO HOT SPRINGS MUDFIELD PHOTOGRAPHIC RECORD

A weekly photographic record was initiated in January 1978 to document the fluctuation in fluid levels in several of the more prominent mud pots in the Coso KGRA. Over the years the photo record has provided a clear picture of this hot springs thermal activity. It has demonstrated the sensitivity of the hot springs to both seasonal weather changes and individual weather events, such as summer thunderstorms. It has also chronicled the changes in thermal activity that occurred throughout the Coso Hot Springs area in the late 1980s. This weekly photo record was continued through this reporting period and is catalogued and stored at the Geothermal Program Office.

Selected photographs, Figures 7 through 15, show the typical level of thermal activity in the hot springs area throughout the past year.

FIGURE 7. Resort Mud Pot Area, August 1998.

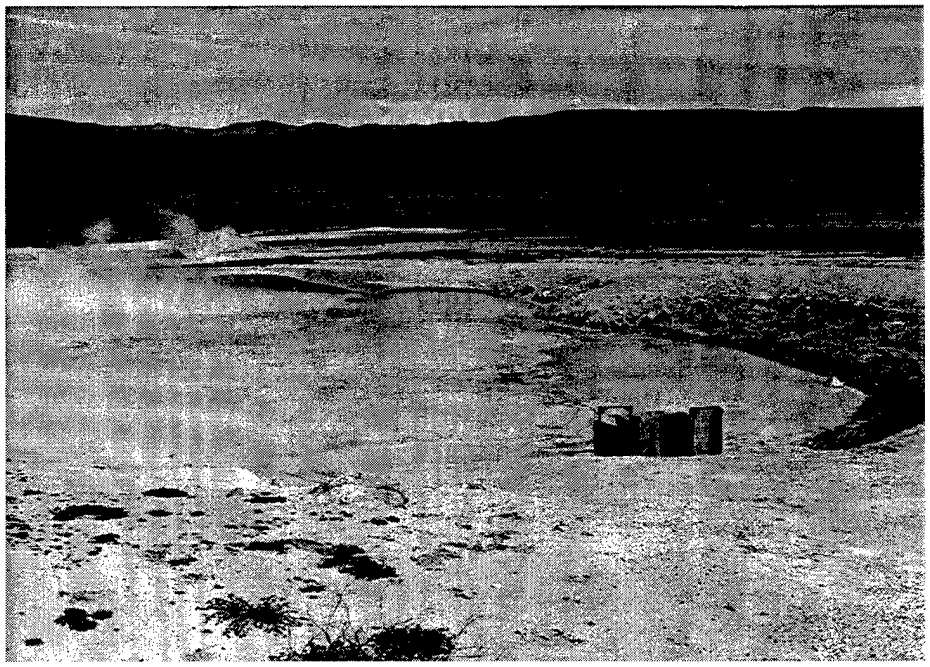


FIGURE 8. South Pool, High Water Level, May 1998.

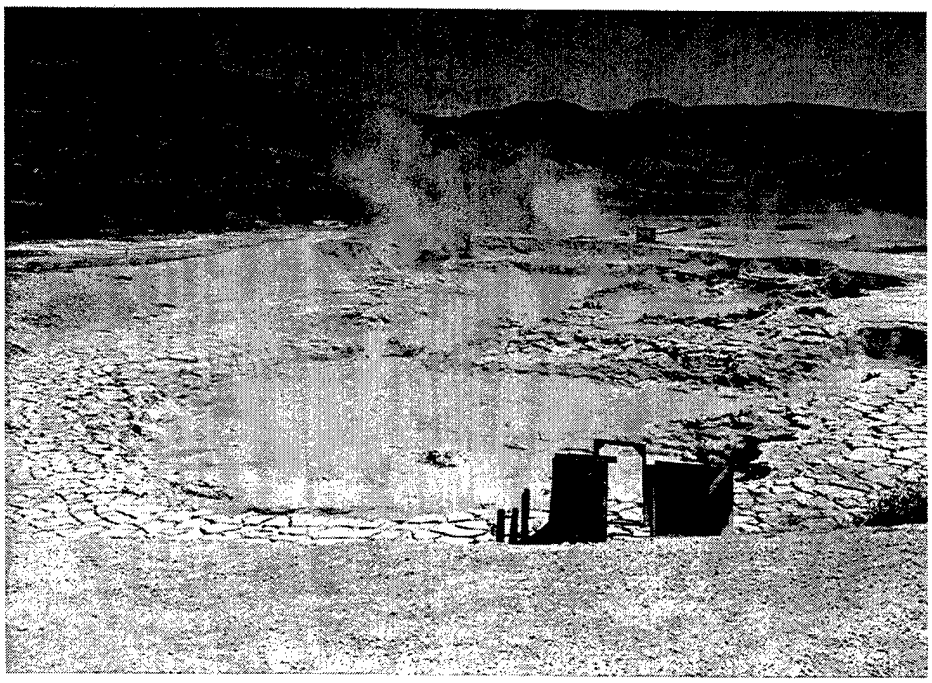


FIGURE 9. South Pool, Low Water Level, October 1997.

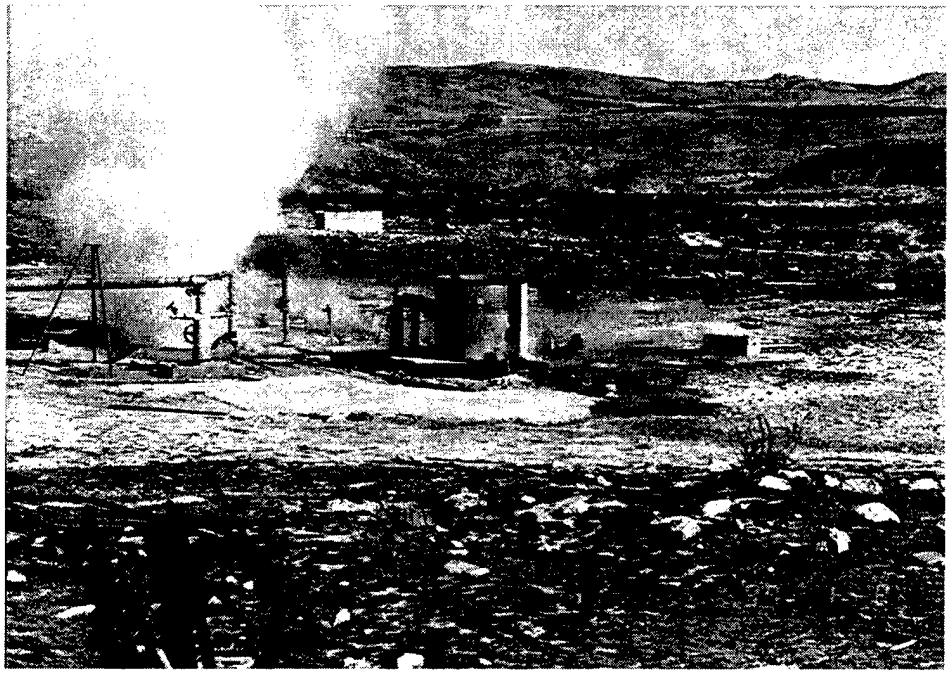


FIGURE 10. Schober's Resort Area.

FIGURE 11. West Canyon, Looking West Up Canyon, September 1998.

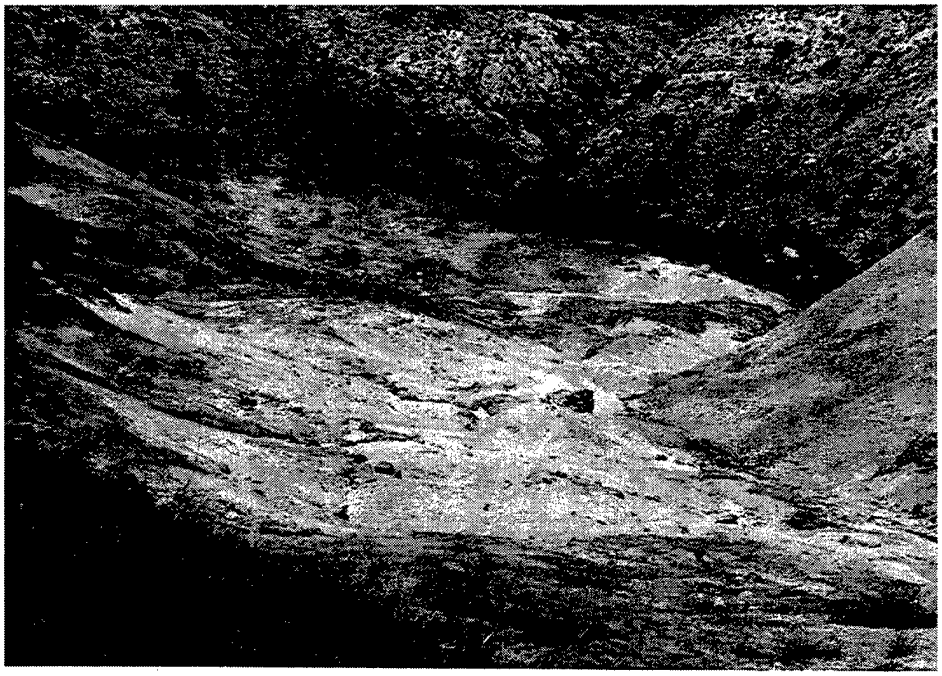


FIGURE 12. Northern West Canyon Land Slump, April 1998.

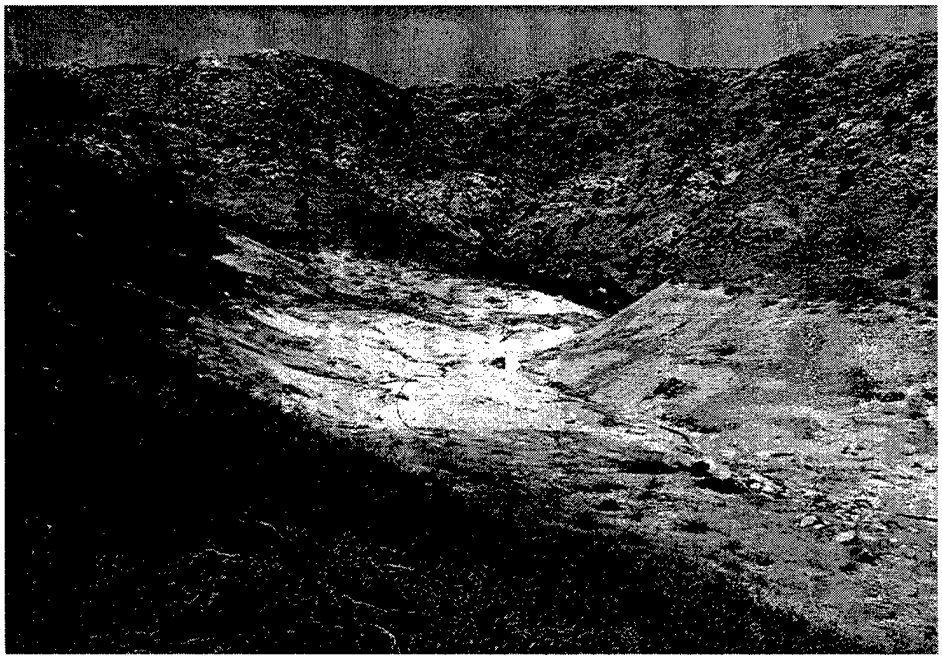


FIGURE 13. Northern West Canyon Land Slump, October 1998.

FIGURE 14. Nichol Prospect Warm Pool, March 1998.

FIGURE 15. Nichol Prospect Warm Pool, August 1998.

WATER LEVEL MONITORING

OBSERVATION WELLS

Groundwater levels are monitored in four wells. Bi-weekly measurements are taken at wells 4P-1, OB-1, and OB-2, while the water level of another well, Coso No. 1 (4H-8), is determined indirectly from temperature logs and weekly wellhead pressure readings. These level data are listed in Table 2. Figure 16 shows a summary graph of observation well water levels from 1980 to the present. Depth to water data have been translated to true elevation.

The fluid level elevation in well 4P-1 appears to have stabilized at 3612.1 feet above sea level (ASL) during this monitoring period. Well 4P-1 is a hot, steam condensate well and is located on the upthrown side of the Coso Hot Springs fault, about 150 feet from the fault line, toward the south end of the hot springs area. It is completed in alluvial fill material. As discussed in Reference 2, this well appears to tap a small perched aquifer that is not directly connected to the regional aquifer.

Observation wells OB-1 and OB-2 are water wells located in the Upper Coso Basin about three-quarters of a mile east of the fault line. Both of these wells are completed in sedimentary valley fill material. The water level elevation in OB-1 continues the decline as described in previous reports, dropping from about 3432 feet ASL in 1988 to about 3372.5 feet ASL by September 1998. The water level in OB-2 declined from 3365.5 feet ASL in October 1997 to 3356.2 feet ASL in September 1998. The mechanical measuring device on well OB-1 no longer works because the water level in the well has dropped below the depth of the measuring tube. An electronic water-level tape measure is now used to measure the water level in OB-1 at the end of each month.

Coso No. 1 is located toward the north end of the Coso Hot Springs fault and is completed in bedrock. The fluid level in Coso No. 1 declined slightly from 3473 to about 3465 feet ASL between 1978 and October 1987. At that lowered fluid level, the well began to boil. The fluid level dropped rapidly to about 3410 feet ASL by September 1988, and the wellbore became plugged with salt and scale. Coso No. 1 was rehabilitated in 1993 and shut-in to reduce boiling and scaling. The 1997 fluid level (determined from the temperature gradient log) was about 3294 feet ASL. The fluid level for 1998 was unobtainable because the valve had corroded shut. We are working to reopen the valve for the 1999 reporting period.

Shut-in wellhead pressures for Coso No. 1 are recorded weekly from both the 4-inch wellbore and the 7-inch intermediate casing around the wellbore. The wellbore is completed to 370 feet in bedrock, with the intermediate casing set to 194 feet at the alluvium/bedrock interface. Table 3 is a listing of the current year's recorded pressures. Figure 17 is a summary graph of these pressures from November 1993 through September 1998.

TABLE 2. Observation Well Water Level Data.

Date	Water level elevations, ft, above mean sea level (AMSL)			
	Ground level at well location, ft, AMSL			Ground level, ft, AMSL
	4P-1	OB-1	OB-2	Coso 1
	3662.0	3570.0	3560.0	3615.0
	Water level measurements			Water level
	4P-1	OB-1	OB-2	Coso 1
1 Oct 97	3613.3	3385.6	3365.5	
8 Oct 97	3612.1	3384.5	3364.3	
15 Oct 97	3613.3	3384.5	3364.3	
22 Oct 97	3613.3	3384.5	3363.2	
29 Oct 97	3613.3	3384.5	3363.2	
5 Nov 97	3613.3		3363.2	
12 Nov 97	3612.1		3363.2	
20 Nov 97	3613.3		3362.0	There are no Coso 1 data this fiscal year.
27 Nov 97	3613.3	3384.5	3362.0	
3 Dec 97	3613.3		3362.0	
10 Dec 97	3613.3		3360.9	
17 Dec 97	3613.3		3360.9	
24 Dec 97	3613.3		3359.7	
31 Dec 97	3613.3	3383.2	3359.7	
7 Jan 98	3613.3		3358.6	
14 Jan 98	3613.3		3358.6	
21 Jan 98	3612.1		3357.4	
28 Jan 98	3613.3	3381.8	3359.7	
4 Feb 98	3613.3		3359.7	
11 Feb 98	3613.3		3358.6	
18 Feb 98	3613.3		3358.6	
25 Feb 98	3613.3	3380.5	3358.6	
4 Mar 98	3613.3		3358.6	
11 Mar 98	3612.1		3357.4	
18 Mar 98	3612.1		3357.4	
25 Mar 98	3612.1	3379.2	3357.4	
1 Apr 98	3612.1		3357.4	
8 Apr 98	3612.1		3357.4	
15 Apr 98	3612.1		3357.4	
22 Apr 98	3612.1		3357.4	

TABLE 2. (Contd.)

Date	Water level elevations, ft, AMSL			
	Ground level at well location, ft, AMSL			Ground level, ft, AMSL
	4P-1	OB-1	OB-2	Coso 1
	3662.0	3570.0	3560.0	3615.0
	Water level measurements			Water level
	4P-1	OB-1	OB-2	Coso 1
29 Apr 98	3612.1	3377.9	3357.4	
6 May 98	3612.1		3357.4	
13 May 98	3614.5		3357.4	
20 May 98	3614.5		3357.4	
27 May 98	3614.5	3376.5	3357.4	
3 Jun 98	3613.3		3357.4	
10 Jun 98	3613.3		3357.4	
17 Jun 98	3613.3		3357.4	There are no Coso 1 data this fiscal year.
24 Jun 98	3613.3	3375.2	3356.2	
1 Jul 98	3612.1		3356.2	
8 Jul 98	3612.1		3356.2	
15 Jul 98	3612.1		3356.2	
22 Jul 98	3612.1		3356.2	
29 Jul 98	3612.1	3373.9	3356.2	
5 Aug 98	3613.3		3356.2	
12 Aug 98	3614.5		3356.2	
19 Aug 98	3614.5		3356.2	
26 Aug 98	3613.3	3372.6	3356.2	
2 Sep 98	3612.1		3356.2	
9 Sep 98	3612.1		3356.2	
16 Sep 98	3612.1		3356.2	
23 Sep 98	3612.1		3356.2	
30 Sep 98	3612.1	3372.5	3356.2	

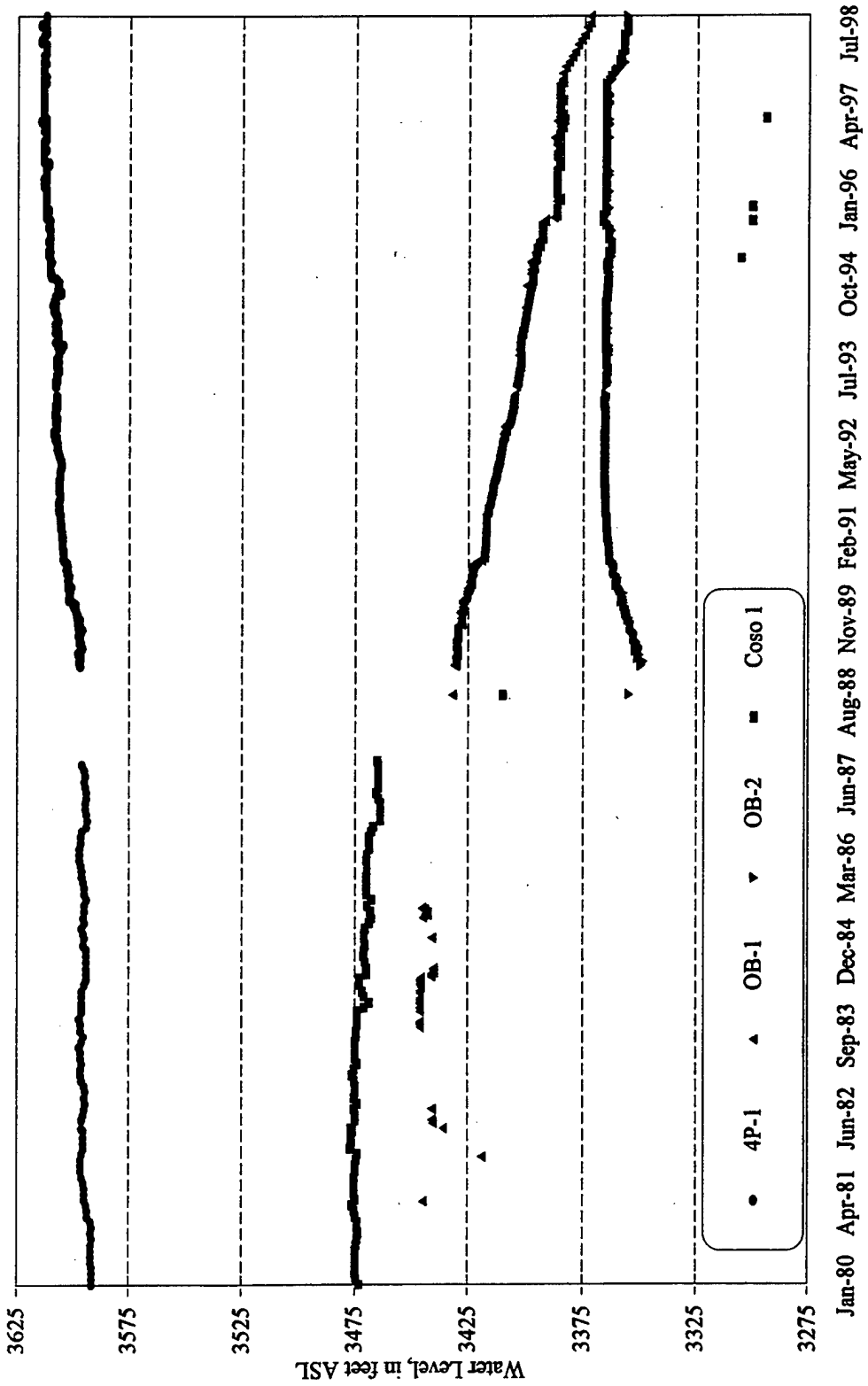


FIGURE 16. Water Levels in Coso Observation Wells, January 1980 Through September 1998.

TABLE 3. Shut-in Wellhead Pressure, Coso No. 1.

Date	7-inch casing (psig)	4-inch casing (psig)
1 Oct 97	25.5	21.0
8 Oct 97	25.5	21.0
15 Oct 97	25.5	20.5
22 Oct 97	25.5	21.0
29 Oct 97	25.5	20.5
5 Nov 97	25.5	21.0
12 Nov 97	25.5	21.0
20 Nov 97	25.5	21.0
27 Nov 97	25.5	20.5
3 Dec 97	25.5	21.0
10 Dec 97	25.5	21.0
17 Dec 97	25.5	21.0
24 Dec 97	25.5	21.0
31 Dec 97	25.5	21.0
7 Jan 98	25.5	21.0
14 Jan 98	25.5	21.0
21 Jan 98	26.0	21.0
28 Jan 98	26.0	21.0
4 Feb 98	26.0	21.0
11 Feb 98	26.0	21.0
18 Feb 98	26.0	21.0
25 Feb 98	26.0	21.0
4 Mar 98	26.0	21.0
11 Mar 98	26.0	21.0
18 Mar 98	26.0	21.0
25 Mar 98	26.0	21.0
1 Apr 98	26.0	21.0
8 Apr 98	25.5	21.0
15 Apr 98	26.0	21.0
22 Apr 98	n.d.	n.d.
29 Apr 98	26.0	21.0
6 May 98	26.0	21.0
13 May 98	26.0	21.0
20 May 98	26.0	21.0
27 May 98	26.0	21.0
3 Jun 98	26.0	21.0
10 Jun 98	26.0	21.0
17 Jun 98	26.0	21.0
24 Jun 98	26.0	21.0
1 Jul 98	26.0	21.0
8 Jul 98	26.0	22.0
15 Jul 98	26.0	21.0
22 Jul 98	26.0	21.0
29 Jul 98	26.0	21.0
5 Aug 98	26.0	21.0
12 Aug 98	26.0	21.0
19 Aug 98	26.0	21.0
26 Aug 98	26.0	21.0
2 Sep 98	26.0	21.0
9 Sep 98	26.5	22.0
16 Sep 98	26.5	22.0
23 Sep 98	26.5	22.0
30 Sep 98	26.0	22.0

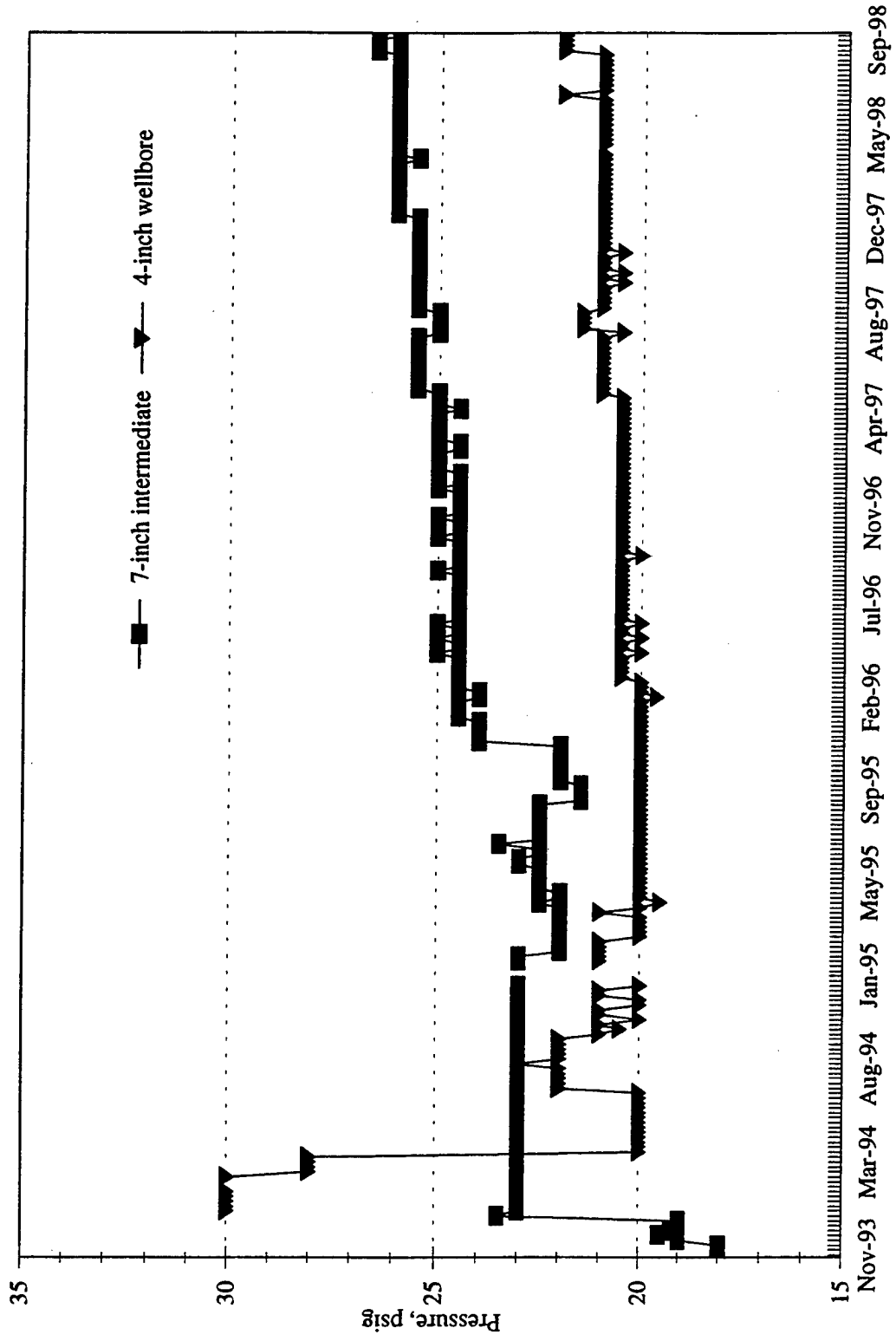


FIGURE 17. Shut-in Wellhead Pressure, Coso Well No. 1, November 1993 Through September 1998.

SOUTH POOL

The South Pool water level has continued the pattern of seasonal fluctuations throughout this reporting period, ranging from a low of 3618.0 feet in October 1997 to a high of 3622.6 feet in April 1998 (Table 4). The pool's temperature is periodically measured, as conditions permit. Water temperatures for this period continued to average above 200 degrees (F). The temperature and water elevations of the pool for January 1988 through September 1998, the period of increased activity, are shown graphically in Figure 18, while the pool elevation recorded for the entire monitoring program period is shown in Figure 19.

TABLE 4. South Pool Elevation and Temperature Changes.

Date	Elevation, ft	Temperature, °F	Date	Elevation, ft	Temperature, °F
1 Oct 97	3618.0	210	8 Apr 98	3622.4	208
8 Oct 97	3618.4	207	15 Apr 98	3622.3	209
15 Oct 97	3618.5	210	22 Apr 98	3622.2	210
22 Oct 97	3618.5	211	29 Apr 98	3622.0	210
29 Oct 97	3618.9	210	6 May 98	3621.9	208
5 Nov 97	3619.0	211	13 May 98	3622.3	209
12 Nov 97	3619.8	209	20 May 98	3622.4	205
20 Nov 97	3620.8	205	27 May 98	3622.4	203
27 Nov 97	3620.9	206	3 Jun 98	3621.7	198
3 Dec 97	3620.9	209	10 Jun 98	3621.0	200
10 Dec 97	3620.9	208	17 Jun 98	3621.0	200
17 Dec 97	3620.9	209	24 Jun 98	3620.4	196
24 Dec 97	3620.9	210	1 Jul 98	3620.5	195
31 Dec 97	3621.0	207	8 Jul 98	3620.0	198
7 Jan 98	3621.2	211	15 Jul 98	3620.9	200
14 Jan 98	3621.3	208	22 Jul 98	3619.3	199
21 Jan 98	3621.3	210	29 Jul 98	3618.1	196
28 Jan 98	3621.4	208	5 Aug 98	3618.8	198
4 Feb 98	3621.5	209	12 Aug 98	3618.7	200
11 Feb 98	3621.6	210	19 Aug 98	3618.1	203
18 Feb 98	3621.6	210	26 Aug 98	3618.0	207
25 Feb 98	3622.0	209	2 Sep 98	3618.8	209
4 Mar 98	3622.0	210	9 Sep 98	3618.0	208
11 Mar 98	3622.1	208	16 Sep 98	3618.2	203
18 Mar 98	3622.3	209	23 Sep 98	3618.4	200
25 Mar 98	3622.5	209	30 Sep 98	3618.2	203
1 Apr 98	3622.6	209			

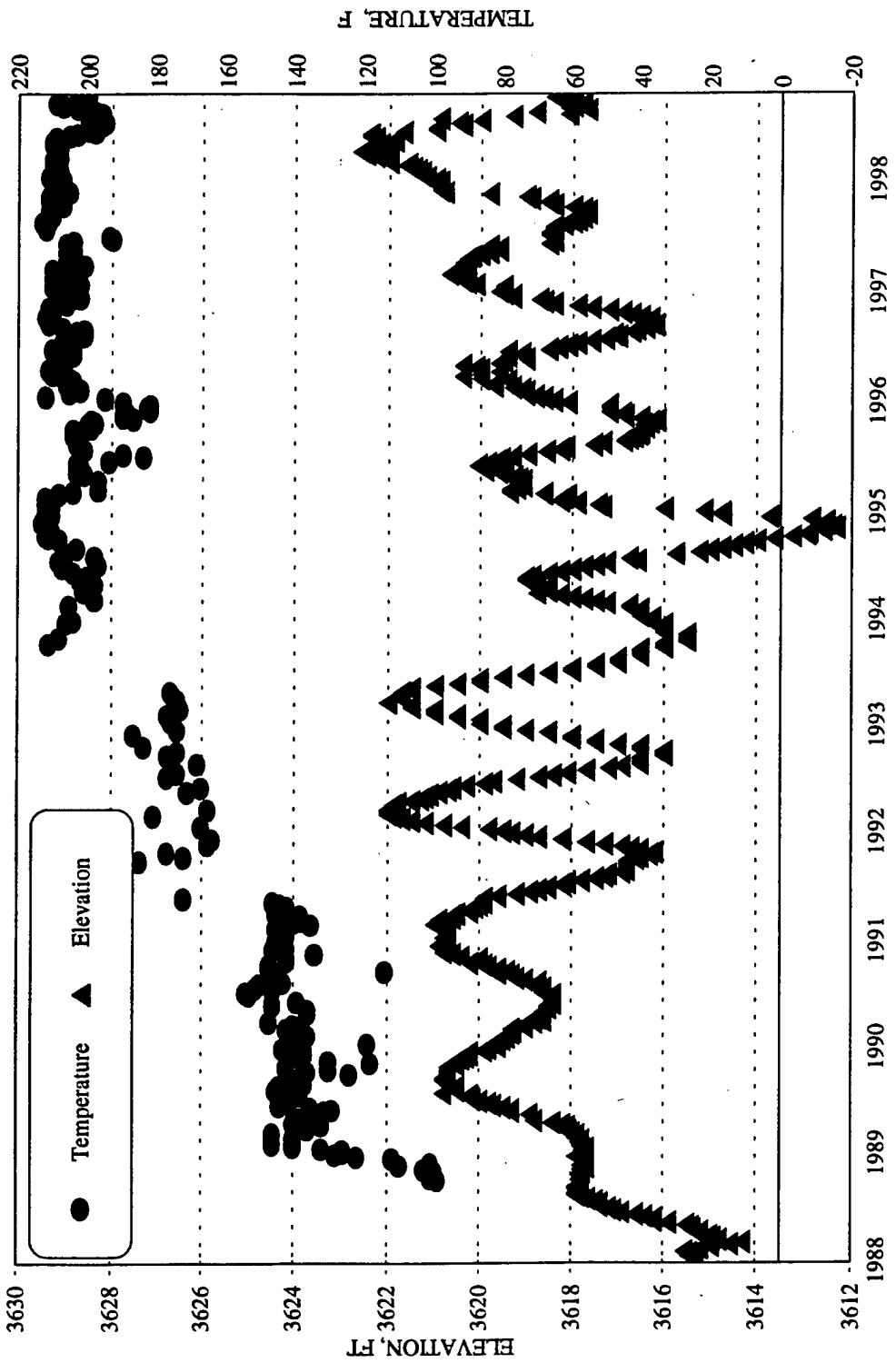


FIGURE 18. South Pool Elevation and Temperature, January 1988 Through September 1998.

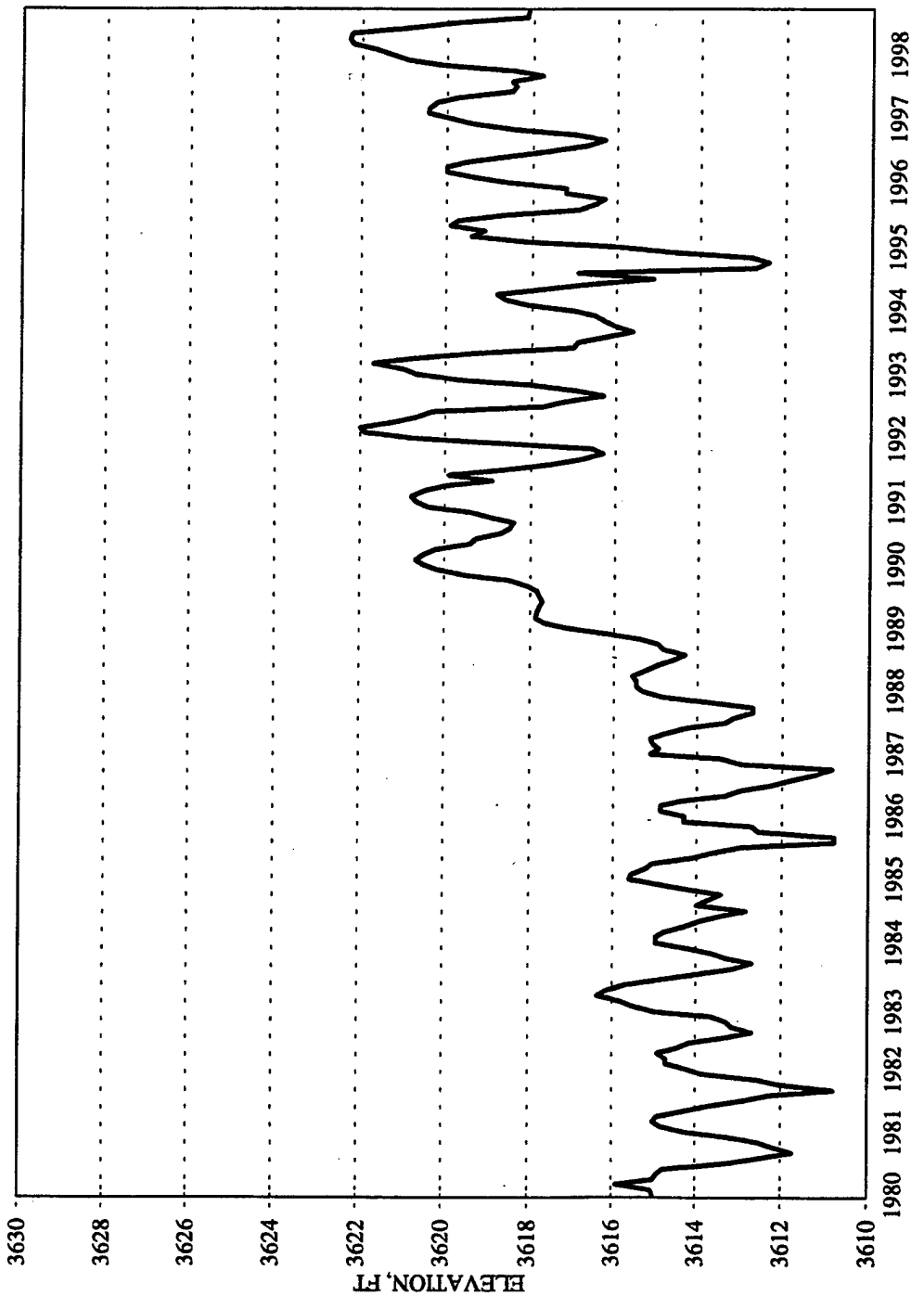


FIGURE 19. South Pool Elevations, January 1980 Through September 1998.

FISCAL YEAR 1998 RAINFALL AT COSO RESORT AREA AND ROSE VALLEY

Rainfall in the Coso Hot Springs basin is monitored at five rain station sites, as mapped on Figure 1. Instrumentation at each site consists of a new electronic event data logger that is triggered by a tipping bucket. No rain data were recorded in tipping buckets for the months of October 1997 to February 1998 due to mechanical problems from the old strip recorders. New data loggers were put into operation in mid February 1998; these are more accurate and reliable than the old strip recorders. The Rose Valley data are collected at the Los Angeles Department of Water and Power Haiwee Reservoir Plant.

Data from the Coso rain stations and the Rose Valley data from the Haiwee power plant are presented in Table 5 and Figure 20. Comparative rainfall data for Coso Basin, Rose Valley, and the Indian Wells Valley (IWV) for the period 1966 through 1997 are shown in Figure 21 and Table 6. IWV data were gathered at Armitage Field, Naval Air Warfare Center Weapons Division (NAWCWD), and provided by a NAWCWD meteorologist.

TABLE 5. Rainfall Recorded at the Coso Rain Stations and Rose Valley.

Coso Hot Springs area						Rose Valley	
Date	Tipping bucket stations (rainfall, in.)					Date	Rainfall, in.
	1	2	3	4	5		
						11 Nov 97	0.12
						12 Nov 97	0.01
						14 Nov 97	0.03
						26 Nov 97	0.01
						27 Nov 97	0.14
						1 Dec 97	0.15
						6 Dec 97	1.47
						8 Dec 97	0.28
						10 Jan 98	0.16
						12 Jan 98	0.14
						19 Jan 98	0.06
						2 Feb 98	0.15
						3 Feb 98	0.19
						4 Feb 98	0.75
						6 Feb 98	0.11
						7 Feb 98	0.53
						8 Feb 98	0.44
						15 Feb 98	0.50
						16 Feb 98	0.17
						20 Feb 98	0.06
						22 Feb 98	0.22
23 Feb 98				0.02		23 Feb 98	0.22
						24 Feb 98	0.74
						6 Mar 98	0.02
10 Mar 98	0.03						
11 Mar 98			0.02				
						14 Mar 98	0.01
25 Mar 98	0.14	0.24	0.16		0.05		0.01
26 Mar 98		0.18	0.01				0.31
						27 Mar 98	0.01
28 Mar 98	0.09	0.03	0.20		0.01		0.05
31 Mar 98	0.26	0.27			0.34		
1 Apr 98	0.25	0.22	0.24		0.25	1 Apr 98	0.38
3 Apr 98	0.01	0.03	0.03				

TABLE 5. (Contd.)

Coso Hot Springs area						Rose Valley	
Date	Tipping bucket stations (rainfall, in.)					Date	Rainfall, in.
	1	2	3	4	5		
						4 Apr 98	0.07
5 Apr 98	0.01					5 Apr 98	0.01
						6 Apr 98	0.01
5 May 98	0.58	0.43	0.36		0.40	5 May 98	0.12
						6 May 98	0.03
7 May 98	0.02	0.02	0.04		0.01	7 May 98	0.01
12 May 98	0.33	0.32	0.19		0.36		
13 May 98	0.15	0.24	0.20		0.25	13 May 98	0.04
14 May 98	0.01					14 May 98	0.04
9 Jun 98	0.02	0.03	0.09		0.08		
10 Jun 98	0.03	0.03	0.02		0.01	10 Jun 98	0.10
						11 Jun 98	0.01
						13 Jun 98	0.04
21 Jul 98	0.03	0.03	0.06		0.07		
22 Jul 98		0.01					
						23 Jul 98	0.38
						12 Aug 98	0.14
13 Aug 98	0.02	0.12	0.24		0.14		
15 Aug 98	0.13	0.09	0.06		0.04		
31 Aug 98	0.17	0.50	0.80	0.26	1.09		
						2 Sep 98	0.01
3 Sep 98	0.03	0.04	0.09	0.07	0.11		
4 Sep 98	0.11	0.11	0.12		0.12	4 Sep 98	0.10
						5 Sep 98	0.09
6 Sep 98	0.63	0.41	0.47	0.10	0.79		
TOTAL	3.05	3.35	3.4	0.45	4.12	TOTAL	9.16

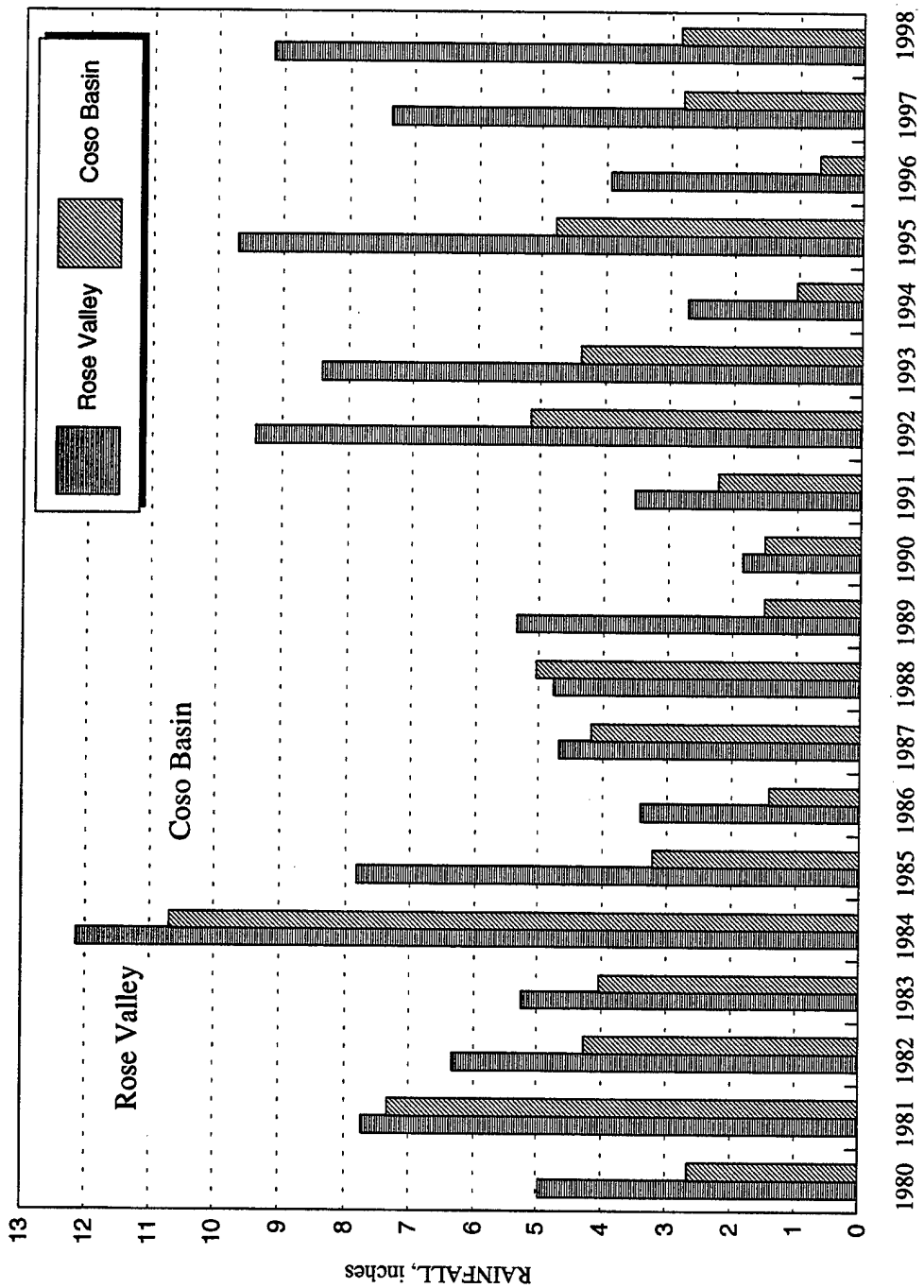


FIGURE 20. Comparison of Total Rainfall at Coso Basin and Rose Valley, Fiscal Years 1980 Through 1998.

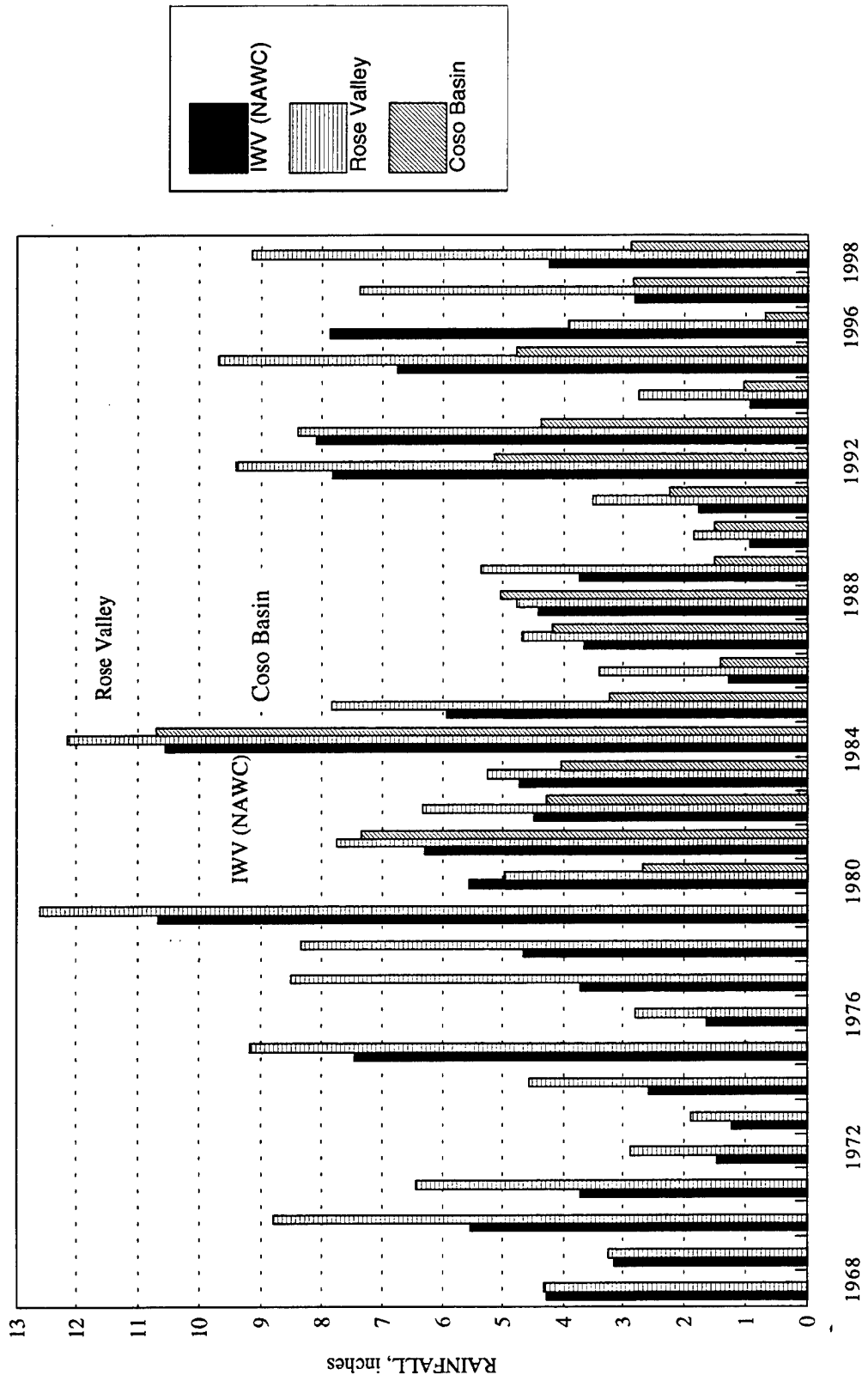


FIGURE 21. Comparison of Total Rainfall at Coso Basin, Rose Valley, and NAWC Sites, Fiscal Years 1968 Through 1998.

TABLE 6. IWV, Rose Valley, and Coso Basin Rainfall, in Inches.

Fiscal Year	IWV	Rose Valley	Coso Basin
1968	4.28	4.32	
1969	3.16	3.26	
1970	5.55	8.80	
1971	3.74	6.45	
1972	1.47	2.87	
1973	1.24	1.90	
1974	2.58	4.56	
1975	7.46	9.19	
1976	1.64	2.79	
1977	3.74	8.50	
1978	4.67	8.34	
1979	10.68	12.61	
1980	5.56	4.97	2.67
1981	6.31	7.75	7.34
1982	4.49	6.34	4.28
1983	4.73	5.26	4.05
1984	10.56	12.14	10.70
1985	5.95	7.84	3.23
1986	1.29	3.42	1.42
1987	3.68	4.68	4.19
1988	4.43	4.77	5.04
1989	3.76	5.36	1.51
1990	0.94	1.85	1.51
1991	1.78	3.53	2.24
1992	7.83	9.41	5.15
1993	8.10	8.4	4.38
1994	0.94	2.74	1.04
1995	6.76	9.69	4.78
1996	7.88	3.94	0.69
1997	2.82	7.37	2.83
1998	4.25	9.16	2.87

COSO HOT SPRINGS MINI-WEATHER RECORDING STATION

Barometric pressure, ambient temperature, relative humidity, and wind speed and wind direction are recorded at Weather Station 1, located adjacent to observation well OB-1. In March 1996 this station was integrated into the base-wide weather monitoring network. This site is now maintained by NAWCWD Geophysics Operation personnel (Code 521410D).

Barometric pressure, ambient temperature, and relative humidity data are presented in Figure 22. Actual hourly data are expansive and will not be published. They are available from the Geothermal Program Office upon request.

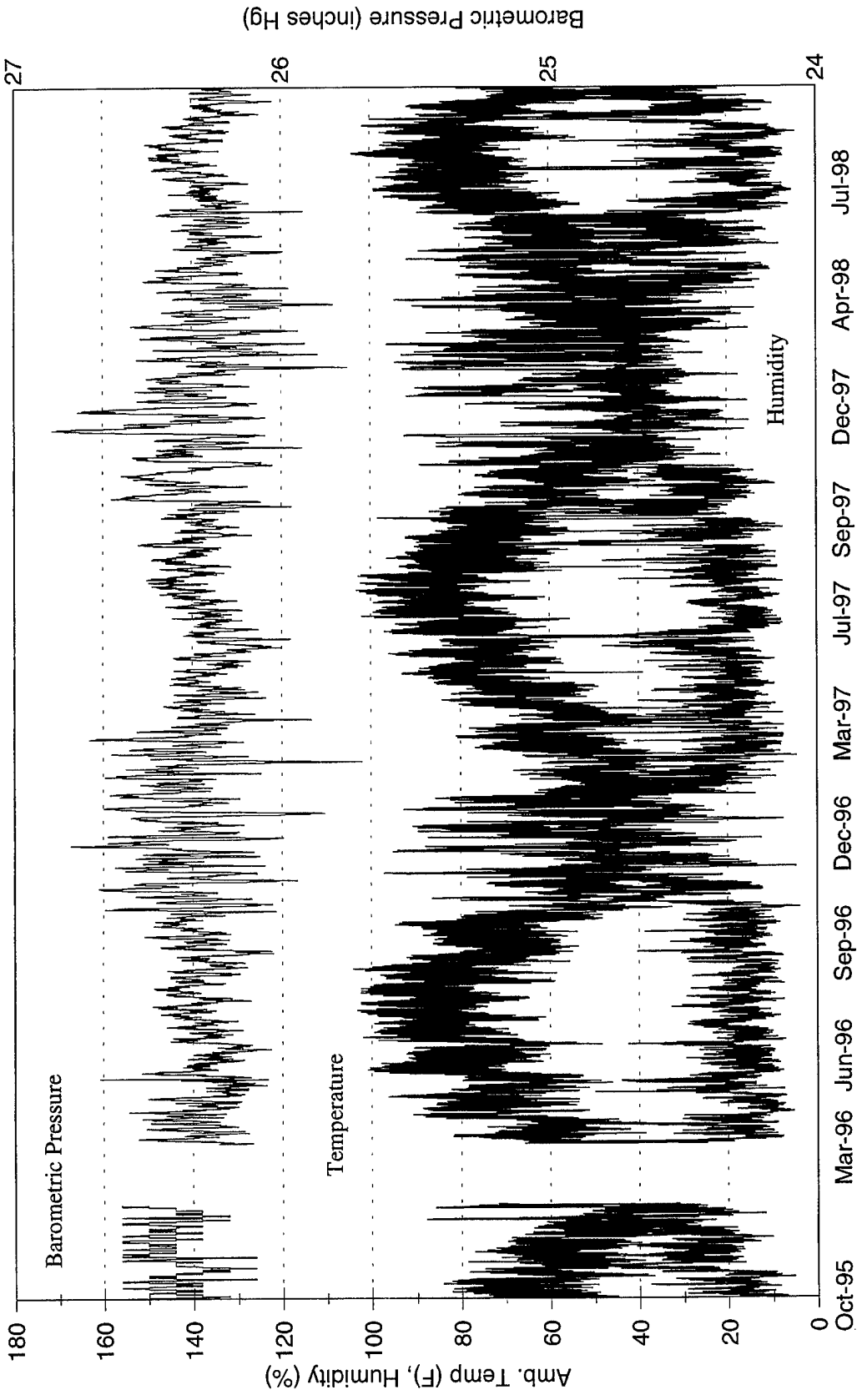


FIGURE 22. Weather Station One, Hourly Data, 19 January 1994 Through 30 September 1998.

WATER ANALYSIS OF COSO HOT SPRINGS AREA

Water samples were collected from several sites in the Coso Hot Springs area. These samples were analyzed for a suite of geothermal constituents by Western Analysis, Inc., of Salt Lake City, Utah. The results are provided in Table 7. Wells 4K-1, 4P-1, and OB-1, as well as sites at Devils Kitchen, South Pool, West Canyon, and the Nichol Pool, were analyzed.

TABLE 7. Chemical Analysis of Coso Area Surface and Near-Surface Thermal Waters.

Constituents	Units	4A-1 4/7/98	4A-1 9/16/98	4K-1 4/7/98	4K-1 9/16/98	4P-1 4/7/98	4P-1 9/16/98	Devils Kitchen 4/7/98	Devils Kitchen 9/16/98	Nicol Pool 4/7/98	Nicol Pool 9/16/98	Fault Line Pool 9/16/98	South Pool 4/7/98	South Pool 9/16/98	West Canyon 4/7/98	West Canyon 9/16/98
Aluminum	mg/L	a	0.800	a	1.220	a	0.860	12.600	15.610	3.550	8.370	3.770	9.330	6.100	a	0.930
Antimony	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	na	a
Arsenic	mg/L	a	0.850	a	a	a	a	a	a	0.110	a	a	a	a	a	a
Bicarbonate	mg/L	238.000	221.000	42.900	39.000	106.000	59.000	a	a	a	a	a	a	a	a	a
Boron	mg/L	48.590	46.540	0.680	0.330	0.580	0.410	3.900	4.620	20.060	19.020	3.870	8.991	2.230	0.660	0.140
Bromide	mg/L	4.000	58.400	a	33.100	a	29.100	a	38.200	2.290	2.400	17.700	2.030	3.600	a	13.000
Calcium	mg/L	41.790	44.320	2.740	4.810	101.290	138.120	61.920	80.480	44.210	51.810	115.700	95.010	91.640	69.350	102.960
Carbonate	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Chloride	mg/L	2390.000	2308.000	4.210	7.180	56.300	58.100	a	a	610.000	765.000	2.990	a	a	8.340	6.140
Conductivity	µmhos/cm	6380	6460	233	238	1450	1820	3570	4110	4240	4380	2250	2950	2220	1120	1260
Copper	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Fluoride	mg/L	3.400	4.450	2.910	3.280	0.940	0.770	1.100	1.280	0.300	0.650	1.470	0.431	1.040	0.720	0.760
Iron	mg/L	0.250	1.050	1.380	1.390	0.920	1.390	49.630	60.510	24.040	27.160	85.210	116.800	110.400	2.420	1.890
Lithium	mg/L	10.480	1.580	0.050	0.040	0.120	0.030	0.080	0.080	2.810	0.430	0.410	0.074	0.110	0.040	0.040
Magnesium	mg/L	4.300	5.000	0.230	0.880	1.310	2.090	23.650	27.700	8.880	9.840	32.070	40.740	42.960	14.940	12.470
Manganese	mg/L	0.810	1.040	0.050	0.070	0.700	0.910	1.610	1.840	0.960	1.150	4.910	3.176	2.840	2.740	2.160
Mercury	µmhos/cm	0.976	0.72	8.17	6.91	1.52	7.44	8.36	7.21	5.19	6.22	2.99	1.55	1.01	2.78	3.07
pH	pH units	7.99	7.27	6.59	6.73	7.67	6.86	2.16	2.34	2.46	2.84	3.87	2.16	3.08	4.83	4.92
Potassium	mg/L	114.420	101.600	5.540	8.230	87.670	99.650	29.340	36.300	88.790	97.640	30.900	35.880	32.950	28.340	34.990
Selenium	µmhos/cm	11	14	a	a	a	a	13	10	a	a	12	14	17	a	a
Silica	mg/L	2.270	0.800	250.990	177.400	276.150	339.000	288.000	319.600	350.020	345.300	185.700	244.590	262.140	223.480	269.000
Sodium	mg/L	1480.000	1530.000	48.740	44.950	200.100	229.930	48.760	58.660	530.500	525.800	83.290	31.560	28.760	124.610	99.400
Strontium	mg/L	2.230	1.910	0.030	0.040	1.590	1.870	0.090	0.130	0.190	0.230	0.140	0.060	0.050	0.190	0.280
Sulfate	mg/L	56.500	22.500	210.000	93.500	602.000	769.000	891.000	901.000	505.000	490.000	802.000	1140.000	866.000	514.000	524.000
TDS	mg/L	4350	4290	580	414	1410	1690	1442	1500	2215	2290	1460	1688	1480	1040	1090
Thallium	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Zinc	mg/L	2.330	0.600	0.250	0.070	0.230	0.620	0.080	na	0.060	a	0.380	0.344	3.960	0.060	0.620

a (none detected)

TEMPERATURE RECORDINGS OF THE COSO RESORT AREA WELLS

The temperature logs from wells 4K-1, 4P-1, and OB-1 are graphed in Figure 23, with the data listed in Tables 8 through 10. These data were recorded using the TD Probe System, manufactured by Natural Progress Instruments, Dallas, Texas.

TABLE 8. Temperature Recordings at Well 4K-1.

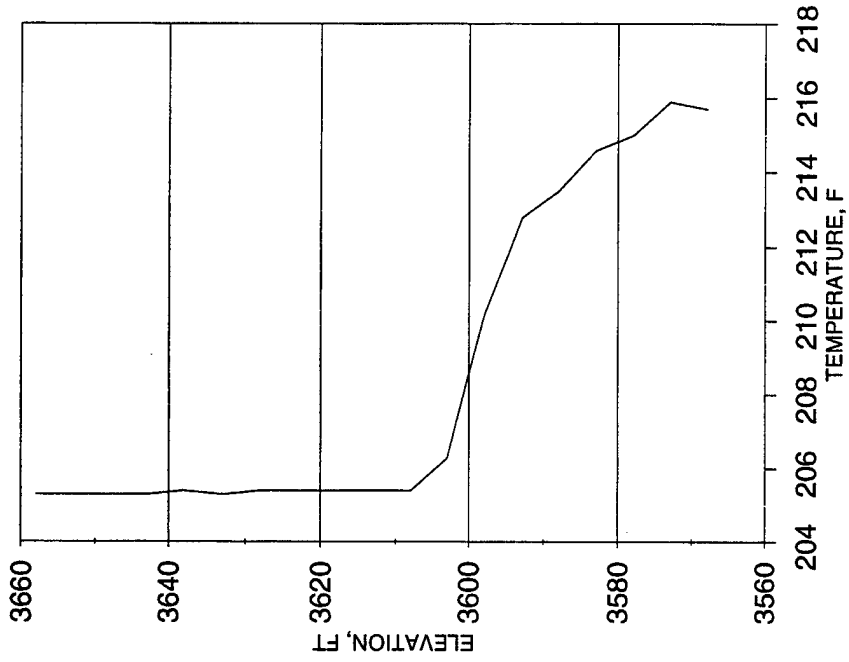
Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 98	Temperature °F on 9 Sep 98
-0	3658	205.3	205.3
-5	3653	205.3	205.3
-10	3648	205.3	205.3
-15	3643	205.3	205.3
-20	3638	205.3	205.4
-25	3633	205.3	205.3
-30	3628	205.3	205.4
-35	3623	205.3	205.4
-40	3618	205.3	205.4
-45	3613	205.3	205.4
-50	3608	205.5	205.4
-55	3603	209.7	206.3
-60	3598	211.6	210.2
-65	3593	213.1	212.8
-70	3588	213.9	213.5
-75	3583	215.5	214.6
-80	3578	216.0	215.0
-85	3573	216.0	215.9
-88	3568	216.0	215.7

TABLE 9. Temperature Recordings at Well 4P-1.

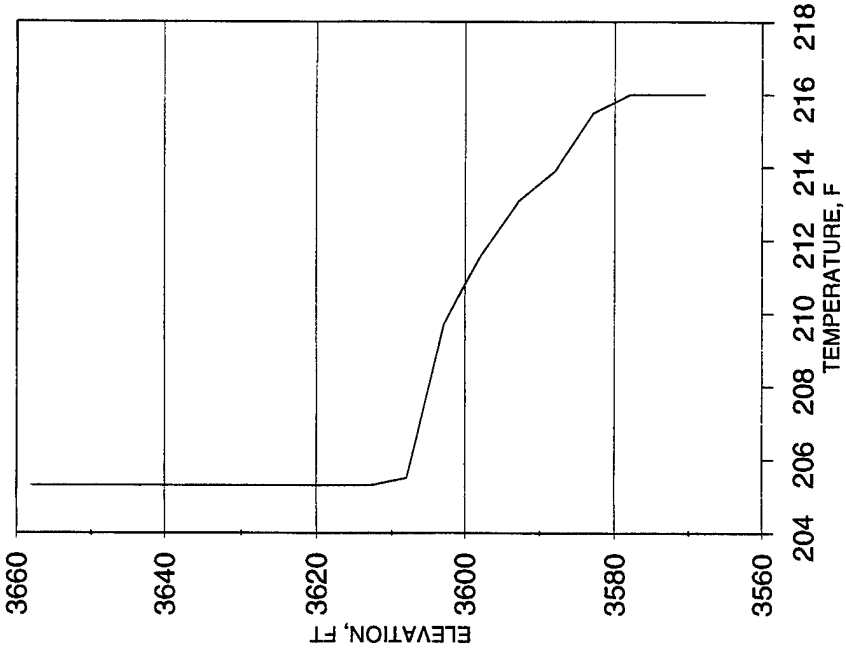
Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 98	Temperature °F on 9 Sep 98
0	3662	188.5	202.3
-5	3657	205.9	205.3
-10	3652	205.9	205.6
-15	3647	205.8	205.5
-20	3642	205.5	205.5
-25	3637	205.5	205.6
-30	3632	205.6	205.6
-35	3627	205.6	205.6
-40	3622	205.6	205.6
-45	3617	205.5	205.6
-50	3612	205.6	205.6
-55	3607	210.6	208.4
-60	3602	214.2	212.3
-65	3597	219.0	216.6
-70	3592	223.0	222.5
-75	3587	223.5	223.2
-80	3582	224.8	224.3
-85	3577	226.2	226.0
-90	3572	228.7	227.4
-95	3567	235.8	233.5
-100	3562	241.0	240.1
-105	3557	252.9	251.5
-107	3552	254.5	251.9

TABLE 10. Temperature Recordings at OB-1.

Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 98	Temperature °F on 9 Sep 98
0	3570	78.5	85.4
-10	3560	78.5	87.2
-20	3550	77.3	85.9
-30	3540	77.3	84.5
-40	3530	77.3	83.5
-50	3520	77.3	82.8
-60	3510	77.3	82.2
-70	3500	77.4	81.8
-80	3490	77.5	81.5
-90	3480	77.5	81.4
-100	3470	77.9	81.3
-110	3460	78.3	81.3
-120	3450	78.8	81.5
-130	3440	79.3	81.8
-140	3430	80.1	82.0
-150	3420	80.8	82.3
-155	3410	81.5	82.4
-160	3400	82.0	82.6
-165	3395	82.6	83.2
-170	3390	82.9	83.4
-175	3385	83.5	83.6
-180	3380	83.8	83.7
-185	3375	84.0	84.0
-190	3370	85.8	84.5
-195	3365	86.5	86.8
-200	3360	86.7	86.9
-205	3355	87.1	87.1
-210	3350	87.3	87.3
-215	3345	87.3	87.3
-220	3340	87.3	87.3
-227	3335	87.3	87.3

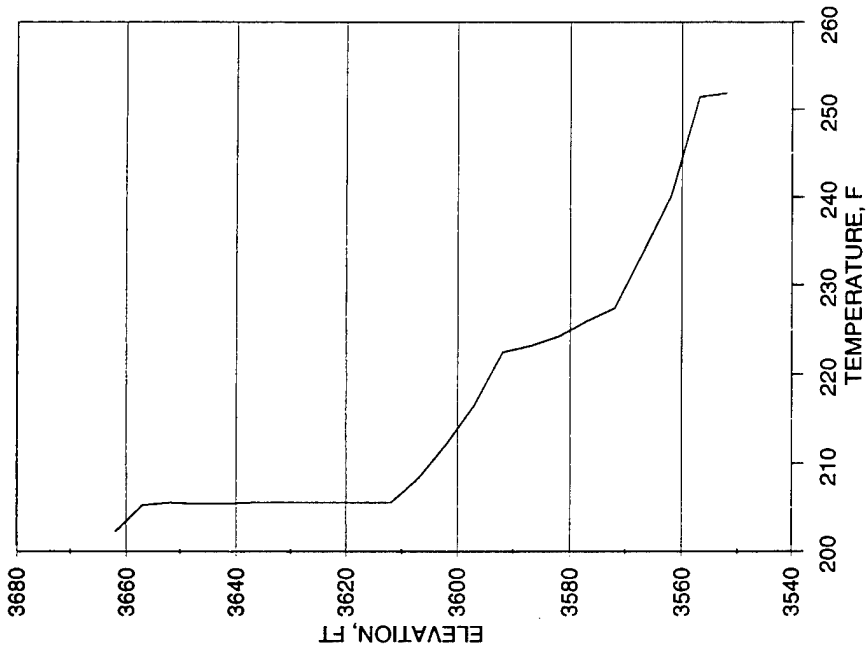


Well 4K-1, 9 September 1998

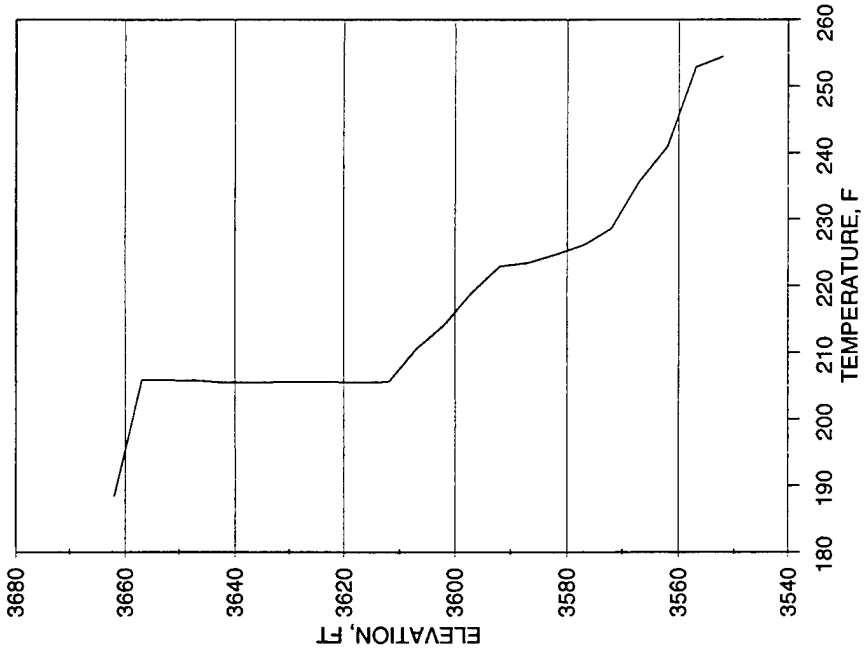


Well 4K-1, 24 March 1998

FIGURE 23. Temperature Gradient Logs, Wells 4K-1, 4P-1, and OB-1.

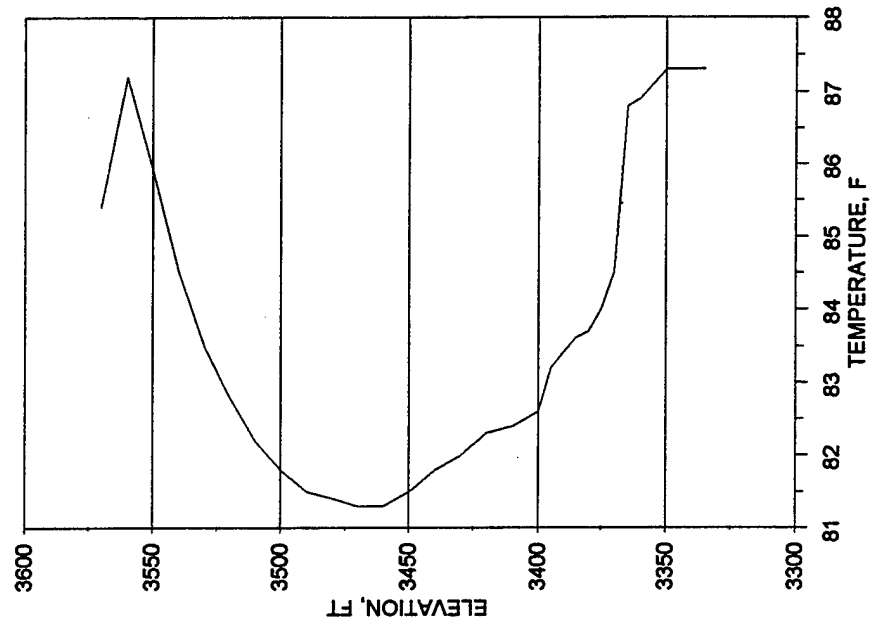


Well 4P-1, 9 September 1998

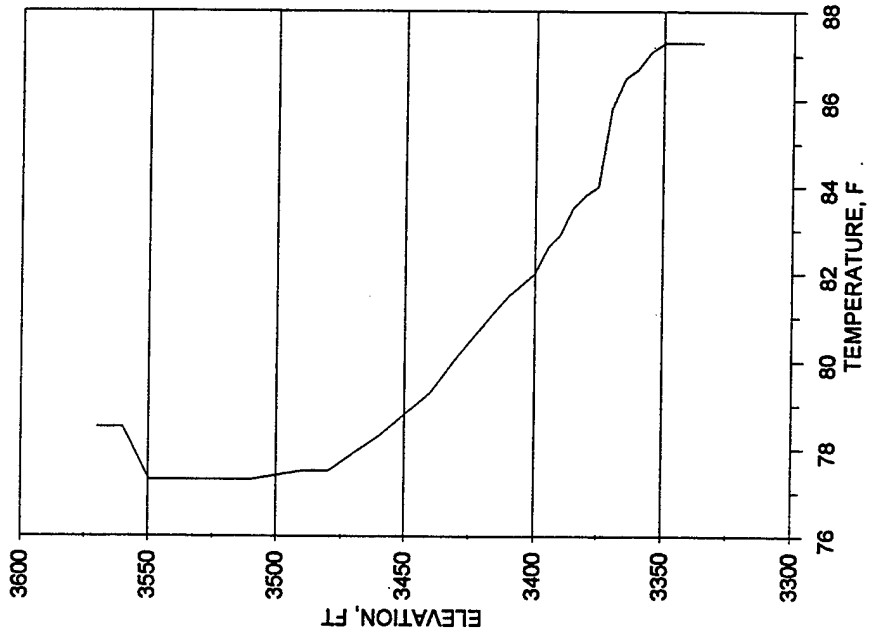


Well 4P-1, 24 March 1998

FIGURE 23. (Contd.)



Well OB-1, 9 September 1998



Well OB-1, 24 March 1998

FIGURE 23. (Contd.)

OTHER GEOTHERMAL ACTIVITY AT COSO HOT SPRINGS

WEST CANYONS

The two west canyons are located approximately 0.7 km west of the Coso Resort area (Figure 1) and on a course perpendicular to the strike-slip fault that runs north and south through the Coso Hot Springs area.

The southerly canyon, which has rain station No. 2 located at the west end, consists of hydrothermal alteration and scattered thermal activity both in the canyon and a wide area at the mouth of the canyon. The geology of this canyon indicates an extensive history of fluctuating thermal activities and features. The prominent area of present activity in the canyon includes an active steam vent bordering a vigorously boiling pool. At a greater distance up the canyon are two diminutive steam vents, small springs and fossil hot spring terrace deposits. Thermal activity in these areas is sporadic, depending upon climatic conditions. Some notable changes in the level of thermal activity have occurred here during this reporting period. An increase in the fluid discharge from the west canyon area has been noted. At first observation it would appear that this is most likely a run-off contribution from the increase in rainfall in the area during the reporting period. However, it has been demonstrated using geochemistry (both elemental and stable isotope) that the water levels in the shallow pools of the Coso Hot Springs area are not significantly affected by local rainfall.

The northerly west canyon holds an extensive area of hydrothermal alteration and fossil hot spring deposits. Present thermal activity is limited to warm-to-hot ground with a small number of steam vents. The earth slump, first noted in NAWS-CL TP 001, has continued to stabilize during the past year. Much of the slump area is warm-to-hot, with steam emanating from multiple vents, specifically along the face of the slump. The small pools of mud and steam condensate, noted in last year's summary, are still present to the west of the slump.

As a whole, these sites appear to be unchanged from last year. One of the indicators of newly heated ground is the die-off of vegetation. The distribution of plant life in these canyons has stayed essentially unchanged.

DISCUSSION AND SUMMARY

The data recovered from each of the steam flow monitoring sites, Devils Kitchen, well 4H-4, and Schober's Resort, have been somewhat erratic during this year, primarily due to mechanical problems with the Barton meters. Repairs to the meters were made and consistent data are expected for next year's report.

The water level in well 4P-1 has risen 21 feet since the beginning of the monitoring program in 1978. Most of this elevation occurred since 1989 and the level seems to have stabilized at 3612.1 feet ASL. The water in this well is predominately a steam condensate and probably represents a small perched water table.

In contrast to wells 4P-1 and OB-2, the water level in well OB-1 continues to drop slightly. Well OB-1 is located adjacent to the south side of Coso Wash and is clearly set in valley fill sediments, so it is unclear why the level has dropped some 40 feet since 1988. Water analyses indicate a significant geothermal fluid component for this water. The groundwater around well OB-1 appears to be seeking equilibrium with groundwater on the north side of the wash (represented by well OB-2).

As discussed in previous monitoring reports, the water level in Coso No. 1 is clearly influenced by the thermal activity along the hot springs fault. The level has dropped about 175 feet since 1984 due to a significant influx of heat and boiling-off of water. Since the wellhead was repaired and the well shut in, the water level appears to have stabilized.

There has been one major change in thermal activity at the South Pool this past year. The north end of the pool developed a new mud pot, which eventually joined the South Pool, increasing the South Pool's diameter by approximately 15%. The water level continues to fluctuate seasonally, as does the water temperature, which exhibits a 10 degree (F) seasonal variation.

Additional observations:

During this reporting period, the central Coso Fault thermal area has changed moderately. The thermal area includes the old corrosion array, the Coso Resort mudfield, the South Pool, and the smaller pool and pots in between. New manifestation in the corrosion array area has formed new mud pots and fumaroles around the existing wells. The mud pots just south of the South Pool also increased in size during this reporting period, and the amount of fluid in the pots appears to have increased also. The Geothermal Program Office is continuing to closely monitor these changes.

The surface ground temperatures at hot spots both around the Upper Coso Wash Valley and along the periphery of the Coso Fault system have remained stable during the monitoring period. A hot spot is identified by warm-to-hot near-surface temperatures, discolored (cooked) soil, and/or die-off of vegetation. The shallow-rooted grasses, scrubs, and deep-rooted creosote bushes that have grown in these hot spots have remained the same since the last monitoring period.

This year's data, particularly that from the surface pools, pots, fumaroles, and hot spots, indicate seasonal fluctuation in temperatures and water levels; no significant increase or decrease of activity is occurring or has occurred during this monitoring period. Continuance of this monitoring program will enable us to determine if this stable trend continues.

PLANS FOR FISCAL YEAR 1999

During the next data gathering period the Coso 1 wellhead valve will be repaired so it will open and close; this will enable us to take water samples and determine the water level in the well. We will continue to monitor, visually and photographically, the new mud pots and increased activity around the Coso 1 Array.

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2. _____. Coso Monitoring Program, October 1991 Through September 1992, by J. H. Monahan and K. L. Larson, Comarco Weapons Support Division, Ridgecrest, Calif. China Lake, Calif., NAWS-CL, December 1992. 123 pp. (NAWS-CL TP 001, publication UNCLASSIFIED.)

Appendix

DAILY STEAM FLOW

4H4 Steam Flow, 10/97 through 9/98 Flow in pounds per hour (pph)				Schobers Steam Flow, 10/97 through 9/98 Flow in pounds per hour (pph)				Devils Kitchen Steam Flow, 10/97 through 9/98 Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
10/1/97	296	294	295	10/1/97	938	917	925	10/1/97	536	517	527
10/2/97	291	290	290	10/2/97	941	924	930	10/2/97	538	524	531
10/3/97	285	279	282	10/3/97	932	924	925	10/3/97	532	516	524
10/4/97	287	279	283	10/4/97	929	920	922	10/4/97	527	515	521
10/5/97	296	280	288	10/5/97	938	920	927	10/5/97	532	516	524
10/6/97	292	289	290	10/6/97	941	930	933	10/6/97	539	523	531
10/7/97	284	275	278	10/7/97	932	920	924	10/7/97	536	516	526
10/8/97	277	273	275	10/8/97	923	908	913	10/8/97	526	513	520
10/9/97	290	274	282	10/9/97	926	914	917	10/9/97	532	516	524
10/10/97	287	284	285	10/10/97	926	917	919	10/10/97	533	521	527
10/11/97	289	274	282	10/11/97	923	905	911	10/11/97	533	510	522
10/12/97	295	281	289	10/12/97	913	905	906	10/12/97	526	509	516
10/13/97	291	274	285	10/13/97	916	902	906	10/13/97	526	508	517
10/14/97	283	270	276	10/14/97	919	889	902	10/14/97	524	510	517
10/15/97	292	280	286	10/15/97	926	914	917	10/15/97	531	516	524
10/16/97	296	289	292	10/16/97	932	905	916	10/16/97	531	517	524
10/17/97	292	274	283	10/17/97	926	917	919	10/17/97	531	518	525
10/18/97	273	269	271	10/18/97	935	920	925	10/18/97	531	518	525
10/19/97	284	269	277	10/19/97	926	917	919	10/19/97	532	518	525
10/20/97	292	284	288	10/20/97	926	917	919	10/20/97	532	517	525
10/21/97	282	269	275	10/21/97	923	911	914	10/21/97	526	515	520
10/22/97	292	280	286	10/22/97	926	911	916	10/22/97	531	516	524
10/23/97	292	279	285	10/23/97	932	905	916	10/23/97	536	523	530
10/24/97	293	284	288	10/24/97	929	920	922	10/24/97	536	516	526
10/25/97	293	286	289	10/25/97	934	920	925	10/25/97	529	510	520
10/26/97	290	289	289	10/26/97	924	917	919	10/26/97	526	510	519
10/27/97	288	281	285	10/27/97	926	917	919	10/27/97	532	516	524
10/28/97	285	279	281	10/28/97	929	914	919	10/28/97	532	517	525
10/29/97	272	273	272	10/29/97	923	902	909	10/29/97	527	513	521
10/30/97	281	277	279	10/30/97	916	905	908	10/30/97	528	510	520
10/31/97	286	281	283	10/31/97	923	905	911	10/31/97	526	515	521
11/1/97	287	279	283	11/1/97	923	908	913	11/1/97	527	515	521
11/2/97	277	277	276	11/2/97	919	905	909	11/2/97	529	510	520
11/3/97	275	270	272	11/3/97	919	908	913	11/3/97	528	516	523

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
11/4/97	267	259	263	11/4/97	919	908	913	11/4/97	529	515	523
11/5/97	271	264	267	11/5/97	923	908	914	11/5/97	532	517	525
11/6/97	280	277	278	11/6/97	923	914	916	11/6/97	532	518	525
11/7/97	268	267	266	11/7/97	923	908	913	11/7/97	532	518	525
11/8/97	266	264	265	11/8/97	924	911	914	11/8/97	531	517	524
11/9/97	262	262	261	11/9/97	924	911	914	11/9/97	531	516	524
11/10/97	267	263	265	11/10/97	926	917	919	11/10/97	538	522	530
11/11/97	280	269	274	11/11/97	923	914	916	11/11/97	534	521	528
11/12/97	281	277	279	11/12/97	919	908	911	11/12/97	535	522	529
11/13/97	266	254	255	11/13/97	910	889	897	11/13/97	532	522	530
11/14/97	289	279	284	11/14/97	926	889	905	11/14/97	534	521	528
11/15/97	277	271	274	11/15/97	919	905	909	11/15/97	538	517	524
11/16/97	272	263	267	11/16/97	910	892	899	11/16/97	535	520	528
11/17/97	258	254	256	11/17/97	894	886	888	11/17/97	539	522	531
11/18/97	267	260	263	11/18/97	894	883	886	11/18/97	542	525	534
11/19/97	274	269	271	11/19/97	894	886	888	11/19/97	543	526	535
11/20/97	282	269	275	11/20/97	913	889	906	11/20/97	544	527	536
11/21/97	292	284	288	11/21/97	910	902	903	11/21/97	532	515	524
11/22/97	287	267	276	11/22/97	910	902	903	11/22/97	532	516	524
11/23/97	288	267	277	11/23/97	910	903	905	11/23/97	526	514	520
11/24/97	283	274	278	11/24/97	919	908	911	11/24/97	528	517	523
11/25/97	283	274	278	11/25/97	919	911	913	11/25/97	526	515	521
11/26/97	281	274	277	11/26/97	913	905	906	11/26/97	528	510	520
11/27/97	282	264	273	11/27/97	913	905	906	11/27/97	531	516	524
11/28/97	284	270	277	11/28/97	910	902	903	11/28/97	535	519	527
11/29/97	282	274	280	11/29/97	910	902	903	11/29/97	534	518	526
11/30/97	277	264	270	11/30/97	907	892	897	11/30/97	538	521	529
12/1/97	272	266	268	12/1/97	910	902	903	12/1/97	536	521	529
12/2/97	277	264	270	12/2/97	907	892	897	12/2/97	538	523	531
12/3/97	275	268	270	12/3/97	913	905	906	12/3/97	544	530	537
12/4/97	268	263	264	12/4/97	882	874	875	12/4/97	549	534	541
12/5/97	262	255	258	12/5/97	907	874	888	12/5/97	548	535	541
12/6/97	273	263	267	12/6/97	907	892	897	12/6/97	555	539	547

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
12/7/97	282	273	277	12/7/97	894	886	888	12/7/97	559	543	551
12/8/97	278	267	272	12/8/97	897	889	891	12/8/97	564	547	555
12/9/97	272	263	267	12/9/97	894	886	888	12/9/97	566	550	559
12/10/97	281	264	276	12/10/97	894	880	885	12/10/97	565	549	558
12/11/97	272	264	267	12/11/97	894	886	888	12/11/97	570	550	560
12/12/97	262	254	258	12/12/97	910	902	903	12/12/97	562	539	551
12/13/97	282	264	273	12/13/97	904	892	895	12/13/97	554	539	547
12/14/97	278	268	273	12/14/97	907	892	897	12/14/97	565	544	555
12/15/97	281	278	279	12/15/97	910	899	902	12/15/97	562	550	556
12/16/97	281	268	274	12/16/97	894	886	888	12/16/97	563	549	556
12/17/97	291	279	285	12/17/97	894	886	888	12/17/97	560	545	553
12/18/97	271	259	265	12/18/97	891	877	881	12/18/97	576	556	566
12/19/97	277	264	270	12/19/97	879	870	872	12/19/97	577	550	564
12/20/97	296	285	291	12/20/97	879	870	872	12/20/97	565	545	556
12/21/97	292	283	285	12/21/97	879	870	872	12/21/97	572	551	562
12/22/97	286	274	280	12/22/97	891	877	881	12/22/97	577	553	566
12/23/97	292	279	285	12/23/97	891	877	881	12/23/97	568	556	562
12/24/97	287	281	283	12/24/97	882	870	874	12/24/97	569	556	563
12/25/97	287	274	280	12/25/97	876	861	866	12/25/97	570	552	562
12/26/97	287	279	283	12/26/97	860	842	849	12/26/97	565	550	558
12/27/97	297	289	292	12/27/97	847	855	849	12/27/97	564	544	555
12/28/97	288	281	284	12/28/97	863	842	850	12/28/97	568	551	560
12/29/97	291	284	287	12/29/97	863	842	850	12/29/97	571	557	564
12/30/97	287	284	285	12/30/97	863	852	852	12/30/97	568	556	562
12/31/97	286	274	280	12/31/97	863	852	855	12/31/97	565	550	558
1/1/98	297	284	290	1/1/98	872	861	864	1/1/98	566	550	559
1/2/98	296	290	293	1/2/98	872	861	864	1/2/98	571	557	564
1/3/98	292	284	288	1/3/98	879	861	867	1/3/98	572	560	567
1/4/98	295	284	284	1/4/98	876	864	867	1/4/98	569	556	563
1/5/98	269	264	266	1/5/98	869	858	861	1/5/98	572	557	565
1/6/98	272	263	267	1/6/98	872	861	864	1/6/98	561	544	553
1/7/98	286	282	283	1/7/98	885	874	877	1/7/98	560	543	552

4H4 Steam Flow				Schobers Steam Flow				Devils Kitchen Steam Flow			
Flow in pounds per hour (pph)				Flow in pounds per hour (pph)				Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
1/8/98	292	284	288	1/8/98	894	880	885	1/8/98	566	544	556
1/9/98	291	285	288	1/9/98	894	886	888	1/9/98	571	556	564
1/10/98	283	276	279	1/10/98	891	877	881	1/10/98	568	556	562
1/11/98	281	265	272	1/11/98	894	880	885	1/11/98	561	549	555
1/12/98	279	264	271	1/12/98	894	886	888	1/12/98	562	544	554
1/13/98	282	276	281	1/13/98	891	877	881	1/13/98	565	551	559
1/14/98	282	279	282	1/14/98	894	883	886	1/14/98	560	544	552
1/15/98	277	274	273	1/15/98	894	886	888	1/15/98	561	547	554
1/16/98	287	269	278	1/16/98	894	886	888	1/16/98	571	549	560
1/17/98	278	274	276	1/17/98	894	886	888	1/17/98	565	549	558
1/18/98	281	272	276	1/18/98	894	880	885	1/18/98	564	547	556
1/19/98	284	275	279	1/19/98	894	883	886	1/19/98	577	551	564
1/20/98	287	281	284	1/20/98	894	886	888	1/20/98	577	553	566
1/21/98	286	280	283	1/21/98	894	886	888	1/21/98	565	551	559
1/22/98	287	278	282	1/22/98	894	886	888	1/22/98	565	551	559
1/23/98	292	273	282	1/23/98	907	889	895	1/23/98	566	548	557
1/24/98	282	274	278	1/24/98	894	886	888	1/24/98	563	549	556
1/25/98	282	275	278	1/25/98	894	886	888	1/25/98	564	550	558
1/26/98	277	269	273	1/26/98	894	886	888	1/26/98	561	549	555
1/27/98	283	274	278	1/27/98	894	886	888	1/27/98	562	550	556
1/28/98	287	280	286	1/28/98	894	886	888	1/28/98	565	551	559
1/29/98	297	279	263	1/29/98	910	902	903	1/29/98	491	526	481
1/30/98	281	271	277	1/30/98	913	905	906	1/30/98	497	533	487
1/31/98	289	277	283	1/31/98	910	902	903	1/31/98	481	526	476
2/1/98	282	278	282	2/1/98	910	902	903	2/1/98	481	466	474
2/2/98	289	285	287	2/2/98	910	903	905	2/2/98	486	475	481
2/3/98	293	288	290	2/3/98	910	902	903	2/3/98	484	472	478
2/4/98	282	276	279	2/4/98	913	905	891	2/4/98	486	472	479
2/5/98	279	273	276	2/5/98	894	886	888	2/5/98	498	482	490
2/6/98	284	277	280	2/6/98	907	889	895	2/6/98	497	483	490
2/7/98	288	283	285	2/7/98	907	899	900	2/7/98	474	471	478
2/8/98	295	285	290	2/8/98	901	889	892	2/8/98	491	477	485
2/9/98	291	287	291	2/9/98	894	886	888	2/9/98			
2/10/98	288	282	285	2/10/98	894	886	888	2/10/98			

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
2/11/98	296	288	292	2/11/98	891	885	886	2/11/98			
2/12/98	297	284	290	2/12/98	885	874	877	2/12/98			
2/13/98	292	284	288	2/13/98	894	880	885	2/13/98	490	480	485
2/14/98	299	289	294	2/14/98	894	886	888	2/14/98	496	477	487
2/15/98	302	299	300	2/15/98	901	889	892	2/15/98	496	465	481
2/16/98	307	299	303	2/16/98	904	892	895	2/16/98	473	459	466
2/17/98	313	304	308	2/17/98	897	889	891	2/17/98	480	466	473
2/18/98	311	301	306	2/18/98	894	886	888	2/18/98	475	465	470
2/19/98	311	296	301	2/19/98	904	895	897	2/19/98	480	465	473
2/20/98	313	299	306	2/20/98	901	892	894	2/20/98	480	464	472
2/21/98	308	298	303	2/21/98	901	892	894	2/21/98	487	475	481
2/22/98	301	293	294	2/22/98	901	892	894	2/22/98	491	476	484
2/23/98	294	284	289	2/23/98	904	892	895	2/23/98	475	464	469
2/24/98	302	293	297	2/24/98	894	888	888	2/24/98	486	472	479
2/25/98	299	287	293	2/25/98	894	880	885	2/25/98	490	476	484
2/26/98	295	290	292	2/26/98	916	908	909	2/26/98	487	475	481
2/27/98	287	283	285	2/27/98	923	913	916	2/27/98	481	468	474
2/28/98	295	279	286	2/28/98	913	905	906	2/28/98	484	471	478
3/1/98	301	284	291	3/1/98	919	908	911	3/1/98	480	466	473
3/2/98	297	290	293	3/2/98	913	902	905	3/2/98	479	465	472
3/3/98	299	288	293	3/3/98	923	908	913	3/3/98	479	466	473
3/4/98	295	279	287	3/4/98	879	866	858	3/4/98	476	464	470
3/5/98	302	285	293	3/5/98	894	874	881	3/5/98	480	467	474
3/6/98	297	274	285	3/6/98	907	877	889	3/6/98	479	465	472
3/7/98	297	293	295	3/7/98	891	877	881	3/7/98	483	469	476
3/8/98	277	269	273	3/8/98	879	858	866	3/8/98	481	468	474
3/9/98	277	269	273	3/9/98	863	827	842	3/9/98	484	471	478
3/10/98	283	280	281	3/10/98	832	788	807	3/10/98	486	474	480
3/11/98	295	284	289	3/11/98	808	796	800	3/11/98	483	471	477
3/12/98	297	287	292	3/12/98	803	796	797	3/12/98	486	474	480
3/13/98	297	279	288	3/13/98	803	796	797	3/13/98	486	476	481
3/14/98	292	280	286	3/14/98	813	799	803	3/14/98	484	466	476
3/15/98	297	289	293	3/15/98	802	796	797	3/15/98	480	469	475

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
3/16/98	297	287	291	3/16/98	802	796	797	3/16/98	484	472	476
3/17/98				3/17/98	802	796	797	3/17/98	486	475	481
3/18/98				3/18/98	832	811	819	3/18/98	479	465	472
3/19/98				3/19/98	828	821	822	3/19/98	479	466	473
3/20/98				3/20/98	816	808	810	3/20/98	483	471	477
3/21/98				3/21/98	819	811	813	3/21/98	480	469	475
3/22/98				3/22/98	832	814	821	3/22/98	480	469	475
3/23/98				3/23/98	828	817	821	3/23/98	484	472	478
3/24/98				3/24/98	832	796	811	3/24/98	487	475	481
3/25/98				3/25/98	800	792	794	3/25/98	491	476	484
3/26/98				3/26/98	800	792	794	3/26/98	486	471	478
3/27/98				3/27/98	800	794	796	3/27/98	486	469	478
3/28/98				3/28/98	797	780	786	3/28/98	492	480	486
3/29/98				3/29/98	786	778	780	3/29/98	486	463	474
3/30/98				3/30/98	800	777	786	3/30/98	474	459	467
3/31/98				3/31/98	785	777	778	3/31/98	484	465	475
4/1/98				4/1/98	832	808	819	4/1/98			
4/2/98				4/2/98	841	827	831	4/2/98			
4/3/98				4/3/98	832	824	825	4/3/98			
4/4/98				4/4/98	832	821	824	4/4/98			
4/5/98				4/5/98	832	821	824	4/5/98			
4/6/98				4/6/98	832	821	824	4/6/98			
4/7/98				4/7/98	819	808	811	4/7/98			
4/8/98				4/8/98	816	805	808	4/8/98	474	464	469
4/9/98				4/9/98	816	802	807	4/9/98	474	464	469
4/10/98				4/10/98	806	799	800	4/10/98	475	463	469
4/11/98				4/11/98	813	799	803	4/11/98	475	465	470
4/12/98				4/12/98	816	799	805	4/12/98	480	469	475
4/13/98				4/13/98	813	802	805	4/13/98	480	469	475
4/14/98				4/14/98	813	799	805	4/14/98	480	467	474
4/15/98				4/15/98	816	808	810	4/15/98	480	469	475
4/16/98				4/16/98	816	808	810	4/16/98	479	465	472
4/17/98				4/17/98	816	808	810	4/17/98	483	471	477

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
4/18/98				4/18/98	819	808	811	4/18/98	492	476	484
4/19/98				4/19/98	819	811	813	4/19/98	491	472	482
4/20/98				4/20/98	816	808	810	4/20/98	481	471	476
4/21/98				4/21/98	816	805	808	4/21/98	480	469	475
4/22/98	301	290	295	4/22/98	816	808	810	4/22/98	490	476	484
4/23/98	302	289	295	4/23/98	816	808	810	4/23/98	491	477	485
4/24/98	297	284	290	4/24/98	819	811	813	4/24/98	489	475	482
4/25/98	282	269	275	4/25/98	817	811	811	4/25/98	486	466	476
4/26/98	287	272	279	4/26/98	817	811	813	4/26/98	480	465	473
4/27/98	287	281	284	4/27/98	816	808	810	4/27/98	481	465	473
4/28/98	272	262	267	4/28/98	832	821	824	4/28/98	480	465	438
4/29/98	275	264	270	4/29/98	841	827	831	4/29/98	461	471	438
4/30/98	273	265	269	4/30/98	841	827	831	4/30/98	439	425	433
5/1/98	273	263	268	5/1/98	847	827	835	5/1/98	439	426	433
5/2/98	272	263	267	5/2/98	844	833	836	5/2/98	442	426	433
5/3/98	278	269	273	5/3/98	847	827	835	5/3/98	451	435	444
5/4/98	272	269	270	5/4/98	847	827	835	5/4/98	450	431	441
5/5/98	277	264	270	5/5/98	844	827	833	5/5/98	451	432	442
5/6/98	273	265	269	5/6/98	844	833	836	5/6/98	445	433	439
5/7/98	286	274	280	5/7/98	838	827	830	5/7/98	445	432	439
5/8/98	292	280	286	5/8/98	832	814	821	5/8/98	455	433	445
5/9/98	282	274	278	5/9/98	832	817	822	5/9/98	458	443	451
5/10/98	292	274	283	5/10/98	832	814	821	5/10/98	455	441	449
5/11/98	289	284	286	5/11/98	822	811	814	5/11/98	462	442	453
5/12/98	290	286	290	5/12/98	816	802	807	5/12/98	462	449	456
5/13/98	287	284	285	5/13/98	816	796	803	5/13/98	457	437	447
5/14/98	282	277	279	5/14/98	800	792	794	5/14/98	474	464	469
5/15/98	272	268	269	5/15/98	816	799	805	5/15/98	454	438	448
5/16/98	281	264	272	5/16/98	810	796	800	5/16/98	457	441	449
5/17/98	287	279	283	5/17/98	816	796	803	5/17/98	468	451	460
5/18/98	278	270	274	5/18/98	813	799	803	5/18/98	462	445	454
5/19/98	282	270	276	5/19/98	22	796	799	5/19/98	475	449	462
5/20/98	285	268	276	5/20/98	803	792	797	5/20/98	475	463	469

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
5/21/98	285	269	277	5/21/98	800	792	794	5/21/98	479	465	472
5/22/98	282	272	277	5/22/98	800	786	791	5/22/98	480	455	468
5/23/98	282	273	277	5/23/98	800	780	788	5/23/98	480	459	470
5/24/98	287	269	278	5/24/98	800	783	792	5/24/98	475	459	468
5/25/98	291	279	285	5/25/98	800	783	792	5/25/98	475	462	469
5/26/98	287	274	280	5/26/98	797	783	788	5/26/98	475	459	468
5/27/98	283	269	276	5/27/98	791	777	782	5/27/98	481	465	473
5/28/98	278	269	273	5/28/98	785	777	778	5/28/98	475	454	464
5/29/98	282	269	275	5/29/98	785	778	780	5/29/98	472	457	464
5/30/98	281	270	275	5/30/98	791	780	783	5/30/98	474	458	466
5/31/98	277	266	270	5/31/98	788	780	782	5/31/98	474	459	467
6/1/98	284	274	279	6/1/98	788	780	782	6/1/98	472	458	465
6/2/98	293	279	285	6/2/98	785	774	777	6/2/98	475	459	468
6/3/98	287	274	280	6/3/98	785	764	772	6/3/98	480	465	473
6/4/98	285	274	279	6/4/98	781	774	775	6/4/98	480	465	473
6/5/98	281	269	275	6/5/98	785	774	777	6/5/98	474	464	469
6/6/98	295	276	285	6/6/98	781	774	775	6/6/98	473	459	466
6/7/98	287	279	285	6/7/98	785	774	777	6/7/98	480	460	470
6/8/98	297	274	285	6/8/98	785	774	777	6/8/98	475	460	468
6/9/98	295	289	291	6/9/98	788	777	780	6/9/98	484	459	472
6/10/98	287	274	280	6/10/98	785	764	772	6/10/98	481	465	473
6/11/98	277	269	273	6/11/98	781	774	775	6/11/98	474	469	466
6/12/98	281	269	275	6/12/98	785	774	777	6/12/98	472	468	465
6/13/98	272	263	267	6/13/98	781	774	775	6/13/98	468	470	463
6/14/98	297	274	285	6/14/98	785	774	777	6/14/98	464	472	456
6/15/98	287	274	280	6/15/98	785	774	777	6/15/98	473	466	464
6/16/98	277	273	275	6/16/98	785	774	777	6/16/98	474	467	467
6/17/98	282	269	275	6/17/98	781	764	771	6/17/98	469	464	467
6/18/98	282	264	273	6/18/98	781	764	771	6/18/98	490	468	480
6/19/98	292	277	284	6/19/98	785	771	772	6/19/98	490	471	481
6/20/98	289	279	284	6/20/98	785	777	778	6/20/98	494	477	486
6/21/98	285	274	279	6/21/98	785	777	778	6/21/98	491	480	486
6/22/98	285	273	281	6/22/98	785	774	777	6/22/98	490	477	484

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
6/23/98	292	276	286	6/23/98	785	774	777	6/23/98	490	477	484
6/24/98	287	274	280	6/24/98	785	758	769	6/24/98	492	477	485
6/25/98	287	275	283	6/25/98	785	777	778	6/25/98	490	476	484
6/26/98	288	268	278	6/26/98	785	774	777	6/26/98	489	477	483
6/27/98	287	270	278	6/27/98	785	774	777	6/27/98	487	472	480
6/28/98	287	273	280	6/28/98	785	774	777	6/28/98	487	475	481
6/29/98	287	269	278	6/29/98	781	764	771	6/29/98	491	476	484
6/30/98	286	272	281	6/30/98	769	758	761	6/30/98	488	475	482
7/1/98	291	270	280	7/1/98	778	752	763	7/1/98	486	475	481
7/2/98	291	278	284	7/2/98	772	752	760	7/2/98	490	465	478
7/3/98	283	274	278	7/3/98	769	755	760	7/3/98	490	477	484
7/4/98	282	269	275	7/4/98	769	755	760	7/4/98	486	475	481
7/5/98	277	269	273	7/5/98	763	752	755	7/5/98	484	471	478
7/6/98	277	264	270	7/6/98	756	749	750	7/6/98	484	471	478
7/7/98	287	267	277	7/7/98	766	749	755	7/7/98	490	477	484
7/8/98	286	269	277	7/8/98	753	746	747	7/8/98	489	471	480
7/9/98	277	269	273	7/9/98	763	752	755	7/9/98	490	475	483
7/10/98	288	280	284	7/10/98	763	752	755	7/10/98	487	476	482
7/11/98	287	273	280	7/11/98	759	749	752	7/11/98	487	466	477
7/12/98	282	270	276	7/12/98	763	752	755	7/12/98	492	465	479
7/13/98	286	269	277	7/13/98	759	749	752	7/13/98	490	469	480
7/14/98	290	274	282	7/14/98	759	749	752	7/14/98	487	469	478
7/15/98	283	273	278	7/15/98	756	730	741	7/15/98	490	472	481
7/16/98	284	274	279	7/16/98	756	749	750	7/16/98	490	473	482
7/17/98	284	271	277	7/17/98	756	749	751	7/17/98	491	465	478
7/18/98	292	272	281	7/18/98	759	749	752	7/18/98	491	469	481
7/19/98	292	278	285	7/19/98	753	746	747	7/19/98	490	469	480
7/20/98	283	269	276	7/20/98	750	733	739	7/20/98	480	473	477
7/21/98	282	262	272	7/21/98	750	736	743	7/21/98	480	474	477
7/22/98	287	269	278	7/22/98	737	724	729	7/22/98	480	475	478
7/23/98	282	274	278	7/23/98	753	718	733	7/23/98	486	474	480
7/24/98	287	274	280	7/24/98	737	721	727	7/24/98	492	476	485
7/25/98	282	269	275	7/25/98	734	721	725	7/25/98	490	474	482

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
7/26/98	282	268	275	7/26/98	737	718	725	7/26/98	484	473	479
7/27/98	286	268	277	7/27/98	737	724	729	7/27/98	494	470	482
7/28/98	292	274	283	7/28/98	744	724	732	7/28/98	492	471	479
7/29/98	291	278	284	7/29/98	737	718	725	7/29/98	497	468	481
7/30/98	292	274	283	7/30/98	744	724	732	7/30/98	491	469	482
7/31/98	282	272	276	7/31/98	747	721	732	7/31/98	490	471	480
8/1/98	276	264	270	8/1/98	750	718	732	8/1/98	491	469	481
8/2/98	282	264	273	8/2/98	750	721	733	8/2/98	487	469	478
8/3/98	281	273	277	8/3/98	750	724	735	8/3/98	487	473	481
8/4/98	281	268	274	8/4/98	750	721	733	8/4/98	490	474	482
8/5/98	287	271	279	8/5/98	750	718	732	8/5/98	490	475	481
8/6/98	291	273	282	8/6/98	753	721	735	8/6/98	491	476	484
8/7/98	294	279	287	8/7/98	753	746	747	8/7/98	491	476	484
8/8/98	287	274	282	8/8/98	750	730	738	8/8/98	490	474	482
8/9/98	282	268	275	8/9/98	750	724	730	8/9/98	480	473	477
8/10/98	282	269	275	8/10/98	734	721	725	8/10/98	481	469	476
8/11/98	281	265	273	8/11/98	737	721	727	8/11/98	480	468	474
8/12/98	282	269	275	8/12/98	734	718	724	8/12/98	486	468	477
8/13/98	281	269	275	8/13/98	737	721	724	8/13/98	492	469	481
8/14/98	283	271	277	8/14/98	744	733	736	8/14/98	490	471	479
8/15/98	282	268	275	8/15/98	750	733	739	8/15/98	487	469	478
8/16/98	285	271	278	8/16/98	750	739	743	8/16/98	492	472	482
8/17/98	287	274	280	8/17/98	744	736	738	8/17/98	486	473	479
8/18/98	284	269	276	8/18/98	750	739	743	8/18/98	486	465	476
8/19/98	282	269	275	8/19/98	741	733	735	8/19/98	487	469	478
8/20/98	282	269	275	8/20/98	741	733	735	8/20/98	487	469	478
8/21/98	283	269	276	8/21/98	737	727	730	8/21/98	491	473	482
8/22/98	287	269	278	8/22/98	750	730	738	8/22/98	451	425	438
8/23/98	292	274	283	8/23/98	753	733	741	8/23/98	439	420	430
8/24/98	287	274	280	8/24/98	750	724	735	8/24/98	410	397	404
8/25/98	275	269	271	8/25/98	747	739	741	8/25/98	410	391	401
8/26/98	281	274	276	8/26/98	737	724	729	8/26/98	405	391	398
8/27/98	273	260	266	8/27/98	734	724	727	8/27/98	399	387	393

4H4 Steam Flow Flow in pounds per hour (pph)				Schobers Steam Flow Flow in pounds per hour (pph)				Devils Kitchen Steam Flow Flow in pounds per hour (pph)			
Date	High	Low	Average	Date	High	Low	Average	Date	High	Low	Average
8/28/98	278	261	269	8/28/98	737	724	729	8/28/98	400	389	395
8/29/98	281	264	272	8/29/98	741	730	733	8/29/98	403	390	398
8/30/98	287	272	279	8/30/98	750	739	743	8/30/98	406	391	399
8/31/98	277	269	273	8/31/98	750	718	732	8/31/98	403	386	395
9/1/98				9/1/98	734	718	724	9/1/98	405	391	398
9/2/98				9/2/98	741	730	733	9/2/98	405	393	399
9/3/98				9/3/98	750	733	739	9/3/98	405	390	398
9/4/98				9/4/98	737	724	729	9/4/98	394	384	390
9/5/98				9/5/98	737	724	729	9/5/98	400	386	393
9/6/98				9/6/98	741	718	727	9/6/98	403	391	398
9/7/98				9/7/98	750	724	735	9/7/98	405	391	398
9/8/98				9/8/98	741	724	730	9/8/98	408	391	400
9/9/98	333	323	327	9/9/98	747	739	741	9/9/98	406	391	399
9/10/98	335	327	330	9/10/98	747	739	741	9/10/98	403	391	398
9/11/98	336	324	329	9/11/98	747	739	741	9/11/98	399	389	394
9/12/98	329	319	323	9/12/98	747	739	741	9/12/98	398	386	392
9/13/98	329	322	325	9/13/98	747	736	739	9/13/98	399	390	395
9/14/98	328	320	323	9/14/98	747	733	738	9/14/98	398	389	394
9/15/98	328	320	323	9/15/98	747	736	739	9/15/98	405	391	398
9/16/98	332	311	321	9/16/98	753	736	743	9/16/98	399	387	393
9/17/98	332	324	327	9/17/98	747	736	739	9/17/98	400	390	395
9/18/98	333	324	328	9/18/98	747	746	744	9/18/98	401	389	395
9/19/98	338	324	330	9/19/98	763	743	750	9/19/98	407	390	396
9/20/98	336	329	332	9/20/98	759	752	753	9/20/98	405	391	398
9/21/98	322	314	317	9/21/98	756	749	750	9/21/98	394	382	388
9/22/98	317	309	312	9/22/98	753	746	747	9/22/98	387	379	384
9/23/98	322	314	317	9/23/98	772	764	766	9/23/98	395	380	388
9/24/98	325	318	321	9/24/98	772	764	766	9/24/98	398	386	392
9/25/98	327	319	322	9/25/98	772	764	766	9/25/98	399	387	393
9/26/98	329	317	322	9/26/98	775	764	768	9/26/98	401	386	394
9/27/98	317	310	313	9/27/98	769	761	763	9/27/98	393	381	387
9/28/98	333	319	325	9/28/98	772	764	766	9/28/98	400	387	394
9/29/98	332	330	330	9/29/98	772	764	766	9/29/98	393	383	388
9/30/98	324	323	323	9/30/98	772	764	766	9/30/98	400	390	395

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